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STOMATOPODA OF THE SOUTHERN AND EASTERN
PACIFIC OCEAN AND THE HAWAIIAN ISLANDS

BY ROBERT PAYNE BIGELOW

WITH TWO PLATES.

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No. 4.— *Stomatopoda of the Southern and Eastern Pacific Ocean
and the Hawaiian Islands*

BY ROBERT PAYNE BIGELOW

INTRODUCTION

THE Stomatopoda comprise a peculiar and well defined order of Crustacea that inhabit the littoral waters of the seas, chiefly in tropical regions. This report deals with collections made by the United States Fish Commission Steamer "Albatross" under the direction of Alexander Agassiz and on other expeditions during the years from 1901 to 1905. The studies were carried on during summer vacations of a very busy life, and suffered many interruptions by other duties and responsibilities, both official and personal. The various sections of this report having been written at different times, some inconsistencies may be expected. Facilities for these studies were afforded by the Biological Laboratories of the Massachusetts Institute of Technology, the United States Fisheries Biological Station, Woods Hole, Mass., the Marine Biological Laboratory of Woods Hole, and especial thanks are due to Dr. W. T. Calman and to Dr. L. A. Borradaile for their hospitality and the permission to examine collections in the British Museum (Nat. Hist.) and the University Museum, Cambridge, England.

With the permission of Mr. Agassiz, the adult forms have been treated separately from the larval forms in the plankton, which have not been studied. The adult forms represent five genera and seventeen species and varieties, of which one species is new. Late postlarval stages of three species of *Pseudosquilla* also are described; one of these, the postlarval stage of *P. ornata*, is described for the first time.

The publication of Kemp's very excellent monograph (1913), based on the extensive collection in the Indian Museum, caused a change from the plan originally contemplated for this report, and greatly simplified the problem. Wherever possible, I have followed him in classification, and I have used the same anatomical terms (1913, p. 12-13).

Under each species, any fact of general biological interest that has come to my attention has been noted. Variability is marked in some species, as *Gonodactylus chiragra*, *G. oerstedii*, *G. glabrous*, *Pseudosquilla ciliata*, and *Squilla oratoria*. *Odontodactylus japonicus* and *Pseudosquilla ciliata* exhibit sexual differences in color, but no structural

secondary sexual characters. On the other hand, *Gonodactylus chiragra*, *G. glabrous*, and *Lysiosquilla maculata* show marked sexual differences in structures not directly connected with reproduction. *Gonodactylus guerinii* seems to be a very interesting case of mimicry.

A few species are used for human food, notably *Lysiosquilla maculata*, *Squilla oratoria*, and *Pseudosquilla ciliata*.

GONODACTYLUS Latreille

Gonodactylus Latreille, Encycl. Méth., 1825, **10**, p. 473.

Gonodactylus H. Milne-Edwards, Hist. Nat. Crust., 1837, **2**, p. 528 (*partim*).

Gonodactylus De Haan, in Siebold's Fauna Japonica, Crust., 1849, p. 220.

Gonodactylus Miers, Ann. Mus. Nat. Hist., 1880, (5), **5**, p. 115 (*partim*).

Gonodactylus Brooks, Voy. H. M. S. "Challenger" Stomatopoda, 1886, **16**, p. 55.

Protosquilla Brooks, *ibid.*, 1886, p. 65.

Gonodactylus Bigelow, Proc. U. S. Nat. Mus., 1894, **17**, p. 492.

Protosquilla Bigelow, *ibid.*, 1894, p. 492.

Gonodactylus Hansen, Isop., Cumac., und Stomatop. d. Plankton-Exped., 1895, p. 86.

Gonodactylus Nobili, Ann. Sci., Nat. Zoöl., (9), 1906, **4**, p. 328.

Gonodactylus Kemp, Mem. Ind. Mus., 1913, **4**, p. 145.

Type Species.—*Gonodactylus chiragra* (J. C. Fabricius, 1781).

Diagnosis.—Stomatopoda with a compact, generally convex and compressed hind body, without dorsal carinae on the first four abdominal segments. Carapace little, if at all narrowed anteriorly, without carinae; gastric grooves distinct, cervical groove entirely absent. Ischio-meral articulation of raptorial claw situated at a point in advance of the proximal end of merus, upper margin of propodus smooth or finely serrate, dactylus inflated at the base and without teeth on the inner margin. Shorter ramus of last three thoracic appendages linear and composed of two segments. Telson variable. Ventral process of uropods terminating in two sharp spines, of which the inner is usually the shorter.

History of the Genus.—The genus *Gonodactylus*, as recognized by Latreille (1825) and subsequent authors, included the Stomatopoda with compact, rounded hind body, without carinae, except on the last two abdominal segments, and with peculiar raptorial limbs, in which the dactylus is dilated at the base and the propodus is without pectination on the inner margin.

In this group Brooks (1886) found three distinct assemblages of species, which he regarded as of generic rank: *Gonodactylus s.s.*, of

which *G. chiragra* is the type; and two others which he named *Protosquilla* and *Coronida*, respectively. The genus *Protosquilla* was made to include all those species in which the sixth abdominal somite is immovably fused with the telson. This Brooks regarded as a primitive character from its resemblance to the condition found in certain larval stages.

In the genus *Coronida* he included *Squilla bradyi* of A. Milne-Edwards (1869) and *Gonodactylus trachurus* of Miers (1884). These species agree in having small antennary scales and uropods, teeth on the inner margin of the raptorial dactylus, and the hind body depressed.

The discovery by the present writer of a species from the Gulf of Mexico, possessing all the characteristics of *Gonodactylus* with the addition of teeth on the raptorial dactylus, led to a fresh examination of the literature and the separation from *Gonodactylus* of another genus under the name *Odontodactylus* Bigelow (1894), of which *Cancer scyllarus* of Linnaeus is the type.

At the time when Brooks set apart the genus *Protosquilla*, the ontogeny of the species in that group was entirely unknown. In 1895 Hansen described a postlarval stage of *Protosquilla folinii* in which the telson is completely movable on the sixth abdominal segment. Whereas in the adult the fusion is so complete that even the suture between the two somites has disappeared. I may add that this is true of the dorsal side only. An examination of specimens in the British Museum (Natural History), which I was permitted to make by the kindness of Dr. W. T. Calman, shows in this and most other species of *Protosquilla* a distinct groove, if not a suture, separating the two somites on the ventral side. From these facts it is evident that Hansen is right in concluding that the chief characteristic of *Protosquilla* is not primitive, as supposed by Brooks, but is a secondary adaptation. He states further that in *Protosquilla trispinosa* White (*pulchella* Miers) the telson is mobile on the sixth abdominal segment, about half as much so as in *G. oerstedii*. Hansen therefore has reunited the *Protosquilla* group with the genus *Gonodactylus*. In this he is followed by Nobili (1906), Giesbrecht (1910), and Kemp (1913).

Kemp divides *Gonodactylus* into four groups of species:

Group I includes *G. chiragra*, *demani*, *graphurus*, and their immediate allies. In these species the anterior angles of the carapace are advanced and rounded. The rostrum has a median spine and rounded, subacute, or rarely acute lateral angles. The mandibular palp has three distinct segments. The uropods are normal.

Group II is composed of six highly specialized and peculiar species;

G. herdmani, *drepanophorus*, *brevisquamatus*, *fimbriatus*, *spinosocarina-tus*, and *furcicaudatus*. The anterior margins of the carapace are as above. The rostrum is trispinous. The uropods are peculiar — the proximal segments of the exopodite extends far beyond the articulation of the distal segment, and the movable spines on its outer edge are usually recurved; the endopodite is usually crescentic.

Group III is nearly equivalent to the genus *Protosquilla* of Brooks, including *G. trispinosus*, *stoliurus*, *excavatus*, *folini*, *brooksi*, *spinosissimus*, and the like. In these species the anterior margins of the carapace do not slope forward. The rostrum is typically trispinous. The mandibular palp consists of two segments. The posterior margin of the sixth abdominal somite is distinctly incurved in the middle. The uropods are normal.

Group IV contains a single species, *G. acanthurus*, in which the antero-lateral angles of the carapace are advanced and the rostrum is trispinous. The mandibular palp is absent. Both the endopodite and the terminal segment of the exopodite of the uropods have setae on only the distal half of their outer margins; the inner margin in each case bears sharp spines.

Considerable differences of opinion have been expressed in regard to the relationships of the species in Group I. For this reason it may be well to give a résumé of the history of the group. At the time of the Challenger Expedition two species had been described. These were *G. chiragra* Fabricius (1781) and *G. graphurus* Miers (1875). In the Challenger collection there was a single female specimen which differed from *G. graphurus* chiefly in the absence of markings on the first five abdominal somites. This was described by Brooks (1886) as *G. glabrous*.

In 1893 Pocock described a small form under the name *G. smithii* which differs from *G. chiragra* in the narrowness of the carinae and strength of the spines on the sixth abdominal somite and telson. In the same year two other species were described. They are very much alike and differ considerably from *G. chiragra* in the form of the carinae on the telson, which is covered by minute spines. These species are *G. demani* Henderson (1893) and *G. spinosus* Bigelow (1893).

In 1895 the definition of *G. chiragra* was made more precise by Hansen, who distinguished, under the name *G. oerstedii*, the Atlantic form with accessory carinae on the intermediate marginal teeth of the telson, entirely absent in the typical Indo-Pacific form. This difference was mentioned and figured by Borradaile (1898), and later was confirmed by the comparison of a large number of specimens, and again figured by the present writer (Bigelow, 1910). There was published

also in 1895 a series of drawings by the late James Wood-Mason. On Plate III of this work figures 3 to 9 are of *G. platysoma*, male and female, clearly showing the sexual differences in this form, which is much more robust than typical *G. chiragra* and entirely lacks lateral marginal teeth on the telson.

A few years later several varieties of *G. chiragra* were described by de Man (1898 and 1902) and by Borradaile (1900). These include var. *acutirostris* de Man (1898), which later was given full specific rank by Borradaile (1907) and by Kemp (1913). Among the varieties of *G. chiragra*, Borradaile included *G. smithii* Pocock and, doubtfully, *G. oerstedii* Hansen.

In 1903 Lanchester published an elaborate and thoughtful treatment of the varieties of *G. chiragra*, and under this name he included all of Kemp's Group I and added a number of named varieties. He classified the varieties under three headings. The first two of these form a bifurcated "transitional scheme," or phylogenetic tree. The starting point of this scheme is var. *tumidus*, "in which there are three much swollen carinae, without spines, on the telson, and no lateral marginal teeth."

From this both lines of variation are in the direction of an increase in the number of central carinae. They lead through forms having an "anchor" on the median carina to forms having five well developed carinae grouped in the centre of the telson. The first line of variation starting from var. *tumidus* leads through intermediate forms to var. *acutus*, var. *smithii*, and var. *glabrous* "term a," ending finally in var. *graphurus*, with spines on the three central carinae. The second heading, or line of variation, begins with var. *incipiens* and ends with var. *glabrous* "term b," having very swollen carinae without spines. By "term" Lanchester means one of the limits of individual variation within a variety. It will be noticed that the two "terms" of var. *glabrous* lie in distinct lines of variation (evolution?), although, as he states, they are connected by numerous intermediate forms. Under the third heading, Lanchester places var. *anancyrus* Borradaile, var. *acutirostris* de Man, *G. spinosus* Bigelow, and other species of Group I, which he regards as varieties of *G. chiragra*, not falling into his transitional scheme of variation.

In his criticism of Lanchester's paper, Kemp (1913), while recognizing the importance of this work, says that a "careful survey of the large collection in the Indian Museum seems to show he failed to lay sufficient emphasis on the more outstanding features of the case." I entirely agree with Kemp, and would add that Lanchester's scheme

seems to me to be an entirely artificial one, based on the study of insufficient material. The development of the sculpturing of the telson and other characteristics of many Stomatopoda depends on three factors: age, sex, and size-limit. All animals tend to approach a certain size as a limit and the maximum size often differs greatly in closely related species and varieties. When these factors are neglected, confusion in classification is sure to follow. Lanchester's varieties *tumidus* and *acutus* furnish a case in point. Through the kindness of L. A. Borradaile, M.A., Sc.D., Fellow of Selwyn College, I was permitted to examine the type specimens in the Cambridge University Museum, and I am convinced that they are merely well developed males and females respectively of *G. platysoma* Wood-Mason. The intermediate forms are probably immature males or very old females.

Lanchester is not followed by many subsequent writers. Jurich (1904) places *G. smithii* Pocock and *G. acutirostris* de Man with the synonyms of *G. chiragra*, without discussing the variations. Lenz (1905) gives *G. chiragra* (Fabr.) including Borradaile's var. A and var. B, *G. chiragra*, var. *smithii* Pocock, and regards as distinct species *G. spinosus* Bigelow and *G. graphurus* Miers. Tattersall (1906) recognizes *G. chiragra* var. *smithii* Pocock, *G. chiragra* var. *incipiens* Lanchester, and *G. glabrous* Brooks.

In his paper on Stomatopoda from the Western Indian Ocean, Borradaile (1907) gives valuable keys to the species of *Gonodactylus*, to the varieties of *G. chiragra*, and to the varieties of *G. glabrous*. Under *G. chiragra* he recognizes the following varieties:

- Var. A, *incipiens* Lanchester 1903 (type)
- Var. B, *anancyrus* Borradaile 1900
- Var. D, *smithii* Pocock 1893
- Var. F, *tumidus* Lanchester 1903
- Var. G, *acutus* Lanchester 1903 (*segregatus* Lanchester, 1903)
- Var. H, *affinis* de Man 1902
- Var. K, *confinis* de Man 1902

Var. A. was designated as the typical form without varietal name in his previous paper. In this he differs from Lanchester who took var. *tumidus* for the type. Varieties C (*acutirostris*) and E. (*oerstedii*) of his previous paper are recognized in this one as distinct species.

Kemp (1913) has made good use of the large collection of Stomatopoda in the Indian Museum by taking it as the basis for a complete revision of the group. Reference to his treatment of the genus *Gonodactylus* has been made in a previous paragraph. He paid especial

attention to the variations of *G. chiragra* and gives the results of the examination of 230 specimens. Of these, six were strikingly different from the rest and included the type specimens of *G. platysoma* Wood-Mason. While not regarding this form as of specific rank, he finds intermediate forms so rare that it constitutes a distinct variety, worthy of a name.

The case is quite different with the other 224 specimens. In these he finds a perfectly continuous series of variations. Of these he gives a table showing the locality, size, sex, and varietal form of each specimen, following Borradaile's key and adding numerous intermediate forms. These represent a grouping of individual variations within the species *G. chiragra* ss., and are not worthy of varietal names, which are rejected in favor of the letters previously used also by Borradaile and by Lanchester.

This whole investigation is of the greatest assistance in a correct classification of these animals, and some of the general results deserve special mention in this place. Kemp observes that there is greater variation among small specimens than among large ones. To explain this condition, he offers three alternative hypotheses: I, specimens exhibiting extreme variations die young; II, there are dwarf races; III, peculiar young animals tend to become more normal at subsequent moults. Kemp is inclined to accept the third hypothesis, and regards the second one as highly improbable. With this I disagree. Great variations in maximum size are found frequently among the species of a genus and among varieties and races within a species. There is no reason why this should not occur in *G. chiragra*, and in fact, the collection at present in my hand seems to afford direct evidence of the existence of dwarf races.

Kemp observes that there is no trace of correlation between sex and varietal form, and his table (1913, p. 159) seems to substantiate this view. But it does not agree with my experience. It is certainly not true of var. *platysoma*. In a previous paper (Bigelow, 1894) I described three species of *Squilla* in which the full grown males differ from the females in having the margins and carinae of the telson thickened to a marked degree. A similar condition obtains in var. *platysoma*. In males over 62.5 mm. long the central carinae of the telson are more or less tumid and are noticeably different from those in the females, which are narrow. Smaller males are like the females. Examination of Lanchester's type specimens in the Cambridge University Museum has convinced me that his var. *F-tumidus* and var. *G-acutus* are identical with var. *platysoma* (Wood-Mason). All of the types of var. *tumidus*

are males, all of var. *acutus* are females, and the intermediate forms (Lanchester, 1903, p. 447) are three females and one small male. I have noticed the same condition in typical *G. chiragra* and in smaller races that may merit classification as distinct varieties. Especially impressive are the cases where two or more specimens are gathered in the same locality. Frequently I have been able to predict the sex of such specimens by comparison of their telsons and have verified the predictions by examination of the genital orifices.

Of Lanchester's varieties of *G. chiragra* as defined by Borradaile 1907, varieties A and B, with carinae of telson rounded or broad, appear to represent the typical male forms of *G. chiragra* ss. (Kemp); while variety D, with these carinae compressed, represents the extreme female form of telson, in the same way that varieties F and G represent the typical male and female characteristics, respectively, of *G. chiragra* var. *platysoma* (Kemp).

The impression that I obtain from the study of a considerable number of specimens, those in the English museums, as well as the present collection, and a longer series from the Philippines (report in course of preparation), is that the shape of the carinae of the telson changes with age, being narrow and compressed in the young and becoming more or less swollen or tumid with increase in size; and this change appears earlier and progresses farther in males than it does in females. To this extent the sculpturing of the telson presents secondary sexual characters.

GROUP I, Kemp, 1913, p. 145

Diagnosis.—Species of *Gonodactylus* in which the anterior margin of carapace slopes forward on either side of the rostrum with the antero-lateral angles well in advance of the rostral base; rostrum with sharp median spine and antero-lateral angles rounded or subacute, rarely acute; mandibular palp with three distinct segments; posterior margin of sixth abdominal somite straight or slightly curved in dorsal view; proximal segment of the exopodite of the uropod projects distally a little beyond the articulation of the ultimate segment, and its external margin is armed with a series of straight, or almost straight, movable spines; endopodite of uropod normal in shape, and, as a rule, in the disposition of its setae.

Type Species.—*Gonodactylus chiragra* (Fabricius).

Species Represented in the Collection.—*Gonodactylus chiragra* (Fabricius); *G. chiragra* var. *platysoma* (Wood-Mason); *Gonodactylus oerstedii* var. *festae* (Nobili); *Gonodactylus glabrous* Brooks.

GONODACTYLUS CHIRAGRA (Fabricius)

- Squilla chiragra* Fabricius, Species Insectorum, 1781, **1**, p. 515.
Gonodactylus chiragra, Latreille, Encycl. Méth., 1825, **10**, p. 473, pl. 325, fig. 2.
Gonodactylus chiragra Kemp, Mem. Indian Mus., 1813, **4**, pp. 155-162, text fig. 2, pl. 9, fig. 107 (*ubi syn.*).
Gonodactylus chiragra var. *smithii* Rathbun, Proc. Zoöl. Soc., 1914, (2), p. 664.
Gonodactylus chiragra Bouvier, Bull. Sci. France et Belg. (7), 1915, **48**, p. 312.
Gonodactylus chiragra Kemp, Philip. Jour. Sci. (D), 1915, **10**, p. 179-181.
Gonodactylus chiragra Alexander, Jour. Proc. Roy. Soc. W. Australia, 1916, **1**, pp. 8-10.
Gonodactylus chiragra Stebbing, Ann. Durban Mus., 1917, **2**, p. 28.
Gonodactylus chiragra Sunier, Inst. Sci. Buitenzorg, Contr. Faune des Indes Néerl., 1918, **1**, fasc. 4, p. 74.
Gonodactylus chiragra Tattersall, Jour. Linn. Soc., Zoöl., 1921, **34**, p. 354.
Gonodactylus chiragra Balss, Kungl. Svenska Vet. Akad. Handl., 1921, **61**, no. 10, p. 5.
Gonodactylus chiragra Parisi, Atti Soc. Ital. Sci. Nat., 1922, **61**, p. 111, fig. 6.
Gonodactylus chiragra Odhner, Göteborgs Vet. Handl. (4), 1923, **27**, p. 8.
Gonodactylus chiragra Edmondson, B. P. Bishop Mus. Bull. 1925, No. 27, p. 60.
Gonodactylus chiragra Hansen, Siboga-Exped. Monogr., 1926, **35**, (Livr. 104), pp. 24-29.
Gonodactylus chiragra Komai, Mem. College of Sci., Kyoto Imp. Univ. (B), 1927, **3**, (3) p. 338.

Diagnosis.—A *Gonodactylus* of Group I, in which the carapace is slightly narrowed in front and its greatest breadth is about three quarters its median length; rostrum with stout median spine, which may extend beyond the middle of the eye stalks, and antero-lateral angles subacute or broadly rounded; eye stalks about one fourth the median length of the carapace, cornea very oblique; mandibular palp with three segments; propodus of raptorial limb greatly dilated at distal end and armed with a single mobile spine; dactylus strongly inflated at base, and with the distal end flexed inward; abdomen strongly arched and smooth, except for lateral marginal carinae, which do not end in spines. Greatest breadth of fifth abdominal somite less than one fifth the total length of the animal; sixth abdominal somite with six longitudinal carinae of variable thickness, with or without terminal spines; telson broader than long, with two small tubercles near the anterior margin close to the intermediate carinae of the sixth abdominal somite. In the centre of the dorsal surface are three smooth longitudinal carinae of variable width, but always separated by a definite interspace. The median one, or crest, may have a terminal spine and usually has small lateral outgrowths at the posterior end, giving it the form of an anchor. The flukes may be separate and may be provided with spines. Sub-

median and intermediate marginal teeth well developed and each provided with a single carina. Lateral margin sharply carinate with a sharp notch representing the lateral tooth, which is never well developed. Basal prolongation of the uropod broad and ending in two strong spines, of which the outer one is the longer and reaches the end of the exopodite. The inner margin of the outer spine is unarmed.

General Description.—Of this species Kemp (1913) has given a long and accurate description which is summarized in the diagnosis given above and need not be repeated here. In a later paper Kemp (1915) gives the results of a study with comparative measurements of a long series from the Philippine Islands, and he concludes that of all varieties that have been recognized by distinct names, only one, var. *platysoma* W.-M., can be maintained. I agree with Kemp in regarding var. *platysoma* Wood-Mason as a distinct variety or subspecies, and in considering as merely individual variations of *G. chiragra* s.s. all of the varieties listed by Borradaile (1907), with two exceptions. The exceptions are var. F and var. G (varieties *tumidus* and *acutus*, Lanchester, 1903), which I have found to be identical with var. *platysoma*. In making this decision concerning the variations of *G. chiragra*, I am relying in part on my own observations on the collections of the U. S. Philippine Expedition, to be described in a subsequent paper, and on other specimens in various museums, in addition to the present collection. See above pp. 109 to 112.

The Samoan investigations of 1902 yielded only six specimens that can, with certainty, be classified as *G. chiragra* s.s. Of these, five are from Apia, and the other from Pago Pago. The largest is a female 68.5 mm. long (S.8).¹ It is of the typical form (var. A). The carinae of the sixth abdominal segment are well rounded and constricted posteriorly into small spines. The carinae of the telson are moderately rounded. The crest is distinctly convex in lateral view; it has a well developed anchor and no spine. The lateral angles of the rostrum are produced forward and are rather broadly rounded at the ends. S.9c is a male 32 mm. long from the coral reefs at Apia. It closely resembles S.8, except that the carinae of the sixth abdominal segment are narrower and their spines stronger, and the "anchor" on the telson is less marked. A larger male, S.10a (51 mm.), from Pago Pago differs from these two by having the carinae of the telson much more swollen (var. AF?). The lateral angles of the rostrum are strongly produced and subacute. Three specimens from the coral reefs at Apia (S.9a, b, and c) have identical markings (Pl. 2, Fig. 1). The small male has been described above. The other two are a male (a) 45.5 mm. long and a female (b) 37 mm. long. The

¹ Each specimen in the collection is given a serial number for convenience of record.

rostrum of the male has subacute lateral angles, and the carinae of the sixth abdominal segment and of the telson are very much swollen. The central one, or crest, is very tumid without spine, and the flukes of the anchor are indistinct (var. AF?). The female has a rostrum like the smaller male (*c*), and its posterior somites differ greatly from the condition found in both males. The carinae are very narrow and on the sixth abdominal somite they are produced without constriction into stout spines. The crest of the telson is very narrow and is produced at the posterior end with a short blunt spine. The flukes of the anchor are distinct and narrow (var. D). There can be no doubt of secondary sexual differences in these specimens. The larger male is very different from the female, and the smaller male is intermediate between the two in respect to the secondary sexual characters, while all three are identical in every other respect and appear to have been collected at the same station. Another female, 40 mm. long from Apia, S.11, is exactly similar to S.9*b*, except for a slight difference in color.

In the collection from Pago Pago, there are two very small specimens (S.10*b* and *c*) that differ so much from the typical *G. chiragra* as perhaps to merit classification in a distinct variety. The lateral angles of the rostrum are not produced at all. The anterior margin on each side of the median spine slopes backward and meets the diverging lateral margin at a rounded right angle. The basal prolongation of the uropods is very well developed and its outer spine extends beyond the distal end of the exopodite. The submedian and intermediate marginal teeth of the telson are well developed, and the lateral tooth is very distinct. In the female (19 mm.) the carinae of the sixth abdominal segment are rather broad and end in strong spines. The crest of the telson is rounded, broader in its anterior half, and ends posteriorly in a stout spine. The anchor flukes are well developed. The other carinae of the telson are strongly developed and narrow. The male shows the sexual differences usually characteristic of larger specimens. The carinae of both the sixth abdominal somite and the telson, except the marginal ones, are very much swollen. The crest of the telson is very broad and convex, and has a small spine at the posterior end. The anchor is indistinct. The length of the eye stalks in both specimens is equal to more than half the median length of the carapace. This seems to be a juvenal character, as also is, perhaps, the form of the rostrum. But the precocious development of sexual differences seems to indicate a dwarf race, similar to one found in the Philippine collection. The present specimens, however, entirely lack accessory carinae, which are characteristic of the Philippine form.

Color.—Kemp (1913, p. 160) notes the variability of the coloring of

this species in the fresh or living condition, the general tone being in some cases yellow, in others dull orange, brick red, or olivaceous brown. He finds also a sexual difference in coloring. The males are, in most cases, very darkly colored on the ventral surface, while the females are invariably pale beneath.

Stebbing (1917) quotes from Mr. Bell Morley the description of a specimen (sex not given) from Durban, South Africa. The color is violet black, with dark red about the tail; legs and antennae orange; and raptorial claws bright violet about the folding place.

Distribution.—All the specimens of *G. chiragra* s.s. in the present collection were taken in Samoa, five of them at Apia. In one case "coral reefs" is given as the station, and probably all were taken during shore collecting. One characteristic female (S.10a) and the two small specimens described above were taken at Pago Pago. According to Kemp (1913), this species has been found over a wide area, extending from Point Natal, Africa to the Red Sea and Gulf of Suez. From there it extends eastward to Japan, Komai (1927). This species was taken at forty nine stations of the Siboga Expedition in the vicinity of the Dutch East Indies, and Hansen (1926) says that it is certainly the most common Stomatopod in the Indo-Pacific Region. In Oceania it has been found as far east as Tahiti. Edmondson (1925), who reports seven specimens from Wake Island, does not know of any records from Hawaii. It appears to be absent from New Zealand and the southern coast of Australia. On the west coast of Australia it has been reported recently by Rathbun (1914), Alexander (1916), and Balss (1921).

The only records from the Pacific Coast of America are by Miers (1880, p. 42) and Nobili (1897, p. 6). Nobili later (1901) described his two specimens from Darien as *G. festae*, now regarded as a variety of *G. oerstedii*; and it seems probable that the "small male from Panama . . . and two males . . . from the West American coast," mentioned by Miers, are of that species or its varieties, described below.

List of Specimens

No.	Locality	Sex	Length
8	Apia	♀	68.5 mm.
9a	Apia, coral reef	♂	46.0
9b	" " "	♀	37.0
9c	" " "	♂	32.5
10a	Pago Pago	♂	51.0
10b	" "	♀	19.0
10c	" "	♂	15.0
11	Apia	♀	41.0

GONODACTYLUS CHIRAGRA var. PLATYSOMA (Wood-Mason)

- Gonodactylus platysoma* Wood-Mason, Figs. and Descr. of Nine Squillidae, 1895, p. 11, pl. 3, figs. 3-9.
- Gonodactylus chiragra* Borradaile, Proc. Zool. Soc. Lond., 1898, p. 34, pl. 6, fig. 8.
- Gonodactylus chiragra* var. *tumidus* Lanchester, Faun. and Geog., Maldives and Laccadives, 1903, **1**, p. 447, pl. 23, figs. 1 and 1a.
- Gonodactylus chiragra* var. *acutus* Lanchester, *ibid.*, 1903, p. 447, pl. 23, figs. 2, 3, and 3a.
- Gonodactylus chiragra* var. F. and G., Borradaile, Trans. Linn. Soc. Zool., 1907, **12**, p. 211.
- Gonodactylus chiragra* var. *tumidus* and var. *acutus* Lenz, in Voeltzkow's Reise in Ostafrika, 1910, **2**, p. 571.
- Gonodactylus chiragra* var. *tumidus* and var. *acutus* Balss, Denk. K. Akad. Wiss. Wien, 1910 (1912), **87**, Fortsetzung, p. 31.
- Gonodactylus chiragra* var. *platysoma* Kemp, Mem. Indian Mus., 1913, **4**, p. 162.
- Gonodactylus chiragra* var. *acutus* Pesta, Denk. k. Akad. Wiss. Wien, 1914, **89**, p. 682.
- Gonodactylus chiragra* var. *platysoma* Bouvier, Bull. Sci. France et Belg., (7), 1915, **48**, p. 312.
- Gonodactylus chiragra* var. *platysoma* Kemp, Philip. Jour. Sci., (D), 1915, **10**, pp. 180-182.
- Gonodactylus chiragra* var. *acutus* Edmondson, Occ. Papers B. P. Bishop Mus., 1921, **7**, pp. 300-302.
- Gonodactylus chiragra* var. *platysoma* Parisi, Atti Soc. Ital. Sci. Nat., 1922, **61**, p. 111.
- Gonodactylus chiragra* var. *platysoma* Odhner, Göteborgs Vet. Handle. (4), 1923, **27**, (4), p. 8.
- Gonodactylus chiragra* var. *platysoma* Komai, Mem. Col. Sci., Kyoto Imp. Univ., (B), 1927, **3**, p. 339.

Diagnosis.—A variety of *G. chiragra* which differs from the typical form in the following particulars: the body is much more depressed and broader, the width of the fifth abdominal segment being more than two fifths the total length of the animal; the dactylus of the raptorial claw is shorter and not at all, or very slightly, bent at the tip; the telson entirely lacks lateral teeth, the lateral marginal carinae tapering evenly and without any interruption to the tips of the intermediate teeth. The carinae of the telson are smooth, the median one having no spine and no anchor-like outgrowths, or at most having them very faintly indicated. The carinae of the sixth abdominal somite and of the telson are narrow in females (Pl. 2, Fig. 2) and young males. In large males they are swollen, the median carinae of the telson becoming very tumid (Pl. 1, Fig. 2).

General Description.—While sorting the material from the Samoan Expedition, I came across five specimens that differ from the associated specimens of *G. chiragra* so strikingly in form of body and in their color pattern that I at once set them aside as representing a new species or variety. Upon comparing them with Wood-Mason's plates, it was at once evident that they are identical with the form that he figured as *G. platysoma*. Unfortunately, his editor was unable to find any description or reference to this species among his notes. This deficiency has recently been supplied by Kemp (1913), who has pointed out the distinctive characters mentioned in the diagnosis above, and has also furnished a table of comparative measurements (1915) showing that in var. *platysoma* the mean ratio of length of carapace to breadth of abdomen is 1.03, whereas in the typical form the mean ratio is 1.22.

In the United States National Museum in Washington, I found one specimen of this variety, No. 45,248, collected by the "Albatross" November 17, 1899, on the fringing reef at Borabora Island in the Society Group. Through the courtesy of Miss Mary J. Rathbun, I was permitted to examine and measure this and other specimens. This is a female 57 mm. long and corresponds in all respects with the specimens from Samoa.

In the summer of 1904, and again in 1910, I had the good fortune to visit the University Museum in Cambridge, England. On the second visit I had with me the specimens from Samoa and was permitted to compare them directly with the ones in the University Museum. There I found nine males and six females of var. *platysoma*, which I examined and measured. Eight measurements were made on each one of five males and six females. The specimens examined included a male figured by Borradaile (1898, pl. vi, fig. 8) as *G. chiragra*, two males labelled "*G. chiragra* var. *tumidus* type," and four females labelled "*G. chiragra* var. *acutus* type." Borradaile's specimen is from Rotuma; the others are Lanchester's types from the Laccadive Archipelago. The other localities represented in the collection at Cambridge are Coin Peros (?), the Loyalty Islands, and the Solomon Islands. The specimens from the Loyalty Islands lacked all color markings except a pair of black spots on the first abdominal somite. It is remarkable that in every other specimen of this variety that I have examined the characteristic pattern is distinctly, and in some cases very well preserved. Lanchester (1903, p. 447) records that his specimens from the Laccadives were accompanied by the following note: "Variegated green and white. The dark patches on the last thoracic segment and the fifth abdominal segment are very characteristic; latter orange red in centre." The

pattern also well shown in Borradaile's figure seems to be highly characteristic of this variety. The typical form of the species (*G. chiragra s.s.*) has several varieties of pattern, all quite different from this one (cf. Pl. 2, Fig. 1), as already pointed out by Kemp (1915).

So far as I am aware, Borradaile (1898) and Lanchester (1903) are the only authors who have taken this variety as representing the typical form of the species. Lanchester is certainly mistaken in citing my work (Bigelow, 1894) among the authorities for that selection, for I had not seen a specimen of this variety until the Samoan collection was put in my hands. Later Borradaile (1907) selected var. A (= var. *incipiens* Lanchester, 1903) as the typical form. I think Kemp (1913, p. 162) is right in following this precedent, and also in setting apart Lanchester's var. *acutus* as a distinct variety under the name var. *platysoma* Wood-Mason. My examination of Lanchester's types shows that his variety *tumidus* should also be included in var. *platysoma*. Komai (1927) suggested that perhaps var. *platysoma* should be restored to the status of a separate species.

Sexual differences in this variety are clearly marked in the sculpturing of the sixth abdominal segment and of the telson. In all females the carinae are narrow (form G = var. *acutus*). In all males that I have examined that are more than 62.5 mm. long, the carinae of these segments, especially the median one of the telson, are more or less swollen, this condition increasing with age (form F = var. *tumidus*). Males of that size or smaller are like the females.

Distribution.—This variety, like the typical form, seems to be an inhabitant of shallow water about coral reefs, and to be widely distributed through the tropical portions of the Pacific and Indian Oceans. The specimens in the Samoan collection are from Apia (one lot labelled "coral reef") and from Pago Pago. Since this collection was made, Pesta (1914) has recorded the capture by Rechinger of two females at Savaii, Samoa; and Komai (1927) reports two males from Jaluit in the Marshall Islands. The other localities, either previously recorded or noted here for the first time, are: Port Blair, Andamans (Wood-Mason's types); Society Islands, Mauritius, and Philippines (Kemp); Mauritius, typical *G. chiragra* collected at the same time (Bouvier); Red Sea (Balss); Rotuma (Borradaile); Minikoi, Laccadives, from the reef (Lanchester); Borabora Island, Society Group, fringing reef, (No. 45,248, U. S. National Museum); Zanzibar and Madagascar (Lenz); Guam and Marquesas (Edmondson); Ryukyu Islands (Parisi). At Samoa and at Mauritius (Bouvier, 1915) the two forms seem to be closely associated.

List of Specimens

No.	Locality	Sex	Length
12a	Apia, Samoa	♀	74 mm.
12b	" "	♂	64
13	Pago Pago, Samoa	♂	81
14a	Apia, coral reef	♀	70
14b	" " "	♀	telson lost

GONODACTYLUS OERSTEDII Hansen

- Gonodactylus chiragra* A. Milne-Edwards, Nouv. Arch. Mus. Hist. Nat., 1868, **4**, p. 65.
- Gonodactylus chiragra* S. I. Smith, Trans. Conn. Acad. Arts and Sci., 1869, **2**, pp. 31 and 41.
- Gonodactylus chiragra* von Martens, Arch. f. Naturg., 1872, **38**, Bd. I, p. 147.
- Gonodactylus chiragra* (pars.) Brooks, Voy. H. M. S. "Challenger," 1886, **16**, Stomatop., pp. 56-58.
- Gonodactylus chiragra* Pocock, Journ. Linn. Soc., 1890, **20**, p. 526.
- Gonodactylus chiragra* Brooks, Mem. Nat. Acad. Sci., 1891, pp. 353-360, pl. 1, fig. 2; pls. 3, 14 and 15.
- Gonodactylus oerstedii* Hansen, Ergeb. Plankton Exped., 1895, **2**, footnote, p. 65.
- Gonodactylus oerstedii* Borradaile, Proc. Zool. Soc. Lond., 1898, p. 35, pl. 5, fig. 3.
- Gonodactylus oerstedii* Rankin, Ann. N. Y. Acad. Sci., 1898, **11**, p. 253.
- Gonodactylus oerstedii* Bigelow, Bull. U. S. Fish Com., 1901, **2**, p. 149, figs. 1, 2.
- Gonodactylus chiragra* var. *oerstedii* Lanchester, Fauna and Geogr. Maldives and Laccadives, 1903, **1**, p. 455.
- Gonodactylus oerstedii* Kemp, Mem. Indian Mus., 1913, **4**, p. 204.
- Gonodactylus oerstedii* Rathbun, Rapp. Visscherij Curacao, 1919, **2**, p. 348.
- Gonodactylus oerstedii* Kemp and Chopra, Rec. Indian Mus., 1921, **22**, p. 309.
- Gonodactylus oerstedii* Parisi, Atti Soc. Ital. Sci. Nat., 1922, **61**, p. 111.
- Gonodactylus oerstedii* Verrill, Trans. Conn. Acad. Arts and Sci., 1923, **26**, p. 189, pl. 50, figs. 3-4; pl. 51, figs. 2-2b.
- Gonodactylus oerstedii* Schmitt, Bijdr. Dierk. Amsterdam, 1924, **23**, p. 80.
- Gonodactylus oerstedii* Schmitt, Univ. Iowa Studies Nat. Hist., 1924, **10**, no. 4, p. 96.
- Gonodactylus oerstedii* Hansen, Siboga-Exped. Monogr., 1926, **35** (Livr. 104), p. 26.

Diagnosis.—A *Gonodactylus* of Group I having cylindrical eyes; the rostrum transverse with acute median spine elevated somewhat above the rounded lateral angles; sixth abdominal segment with six dorsal carinae, the submedian and intermediate pair being well rounded, more or less elliptical in outline, and often possessing a minute pos-

terior spine, the lateral pair narrow, ending in the strong posterior lateral spines, a transverse carina extending between the ends of the lateral carinae, visible only when the abdomen is flexed; telson with three high rounded central carinae, the median one usually with anchor; submedian marginal teeth large, with minute mobile tips and finely serrated on the inner edge, the total length of the telson being equal to or less than the breadth, intermediate teeth prominent, and lateral pair obsolete; lateral margin sharply carinate, and strong submedian and intermediate marginal carinae, each one of the latter having on its inner side a short *supplementary carina* (Bigelow, 1901, fig. 1, *sc.*), which is attached to the main carina at both ends and separated by a deep groove from the intermediate denticle; the central carinae with or without a *single* terminal spine, and supplementary carinae sometimes slightly serrated; otherwise, the surface of the sculpturings of the telson is smooth and polished. The basal prolongations of the uropods end in two flattened curved spines of which the outer one is the longer and reaches beyond the end of the exopodite; mobile spines of exopodite, straight or curving inward.

General Discussion.—The most abundant species of *Gonodactylus* in the Atlantic and West Indian region is *G. oerstedii*. It resembles closely the equally abundant typical form of *G. chiragra* of the Indo-Pacific region. It differs chiefly in the possession of a "supplementary," or accessory, carina on the inner side of each intermediate marginal carina of the telson (Hansen, 1895; Bigelow, 1901, fig. 1). This feature appears to be invariably present, except in very young specimens (less than 20 mm., Kemp and Chopra, 1921; 6 to about 12 mm., Hansen, 1926).

On the Pacific coast of America is found a third form to which Nobili (1901) has given the name *G. festae*. It resembles *G. oerstedii* in the arrangement of the carinae of the telson, and differs from both the other two in the possession of numerous spinules on the submedian and accessory marginal carinae and in the form of the rostrum.

G. festae is represented in the present collection, and the discovery of an intermediate form makes it appear to be more properly a variety of *G. oerstedii* than a distinct species.

The intermediate form is found in the West Indies and Atlantic Coast of South America, and has been described by Schmitt (1924) as *G. oerstedii* var. *spinulosus*.

We seem here to have a case analogous to *G. demani* with its varieties *spinosus* and *espinosus*, one of which is widely separated geographically from the others (Kemp, 1913), and is the most aberrant. In the

same way we have *G. oerstedii* s.s. and var. *spinulosus* which occupy the same area; but the variety differs from the typical form in the possession of spinules on the telson, and is intermediate between the typical form and *G. festae*, which is separated from the other variety by the Isthmus of Panama, and differs still further from the typical form in the shape of the rostrum. Therefore, *G. festae* Nobili, which is represented in the present collection by a specimen from Panama, will be described as a variety of *G. oerstedii*.

It is not surprising to find the same species of similar forms with slight differences on the two sides of the Isthmus of Panama, a land barrier that arose during the upper Miocene Period.¹ Similar results were obtained from the study of the species of *Squilla* (Bigelow, 1894). *Squilla intermedia* is an Atlantic form, and two closely related species, *S. panamensis* and *S. biformis*, are probably entirely confined to the Pacific Coast of America (cf. Calman, 1917, p. 140). The wide stretch of open sea between the archipelagos of the southern Pacific and the shores of America seems to be a more efficient barrier than a comparatively recent land mass like the Isthmus of Panama. Thus we have *G. chiragra* and its variety *platysoma* occupying a wide area in the Indo-Pacific region, but unknown in Hawaii and on the shores of the American Continent. In the same way, *G. oerstedii* and its varieties *festae* and *spinulosus* occupy similar stations in the western Atlantic, West Indies, and Pacific shores of tropical America.

In the three species of *Squilla* it is the intermediate one that is separated by the impassible barrier. This does not seem to be the case with the varieties of *G. oerstedii*, which thus seem to furnish an exception to Jordan's law of distribution.

Size.—The largest specimen of *G. oerstedii* in the Porto Rico collection is a male 53 mm. long and there were fifteen specimens over 40 mm. long.

Distribution.—The typical form of this species is widely distributed in shallow water on the shores of the mainland and islands of the Atlantic Coast of tropical America, as was indicated by Smith (1869), who had examined specimens from the Bermudas, Florida keys, Aspinwall (now Colon), and Caravellas and Abrolhos in Brazil. There are numerous records from the Bahamas and islands of the Caribbean Sea and the Gulf of Mexico. Pocock (1890) records the occurrence of this species at Fernando Noronha in the south Atlantic, and Rathbun gives its northern limit as North Carolina. It has also a limited distribution

¹ There may have been a narrow connection between the Atlantic and the Gulf of California during the Pliocene (Vaughan, 1919, U. S. Nat. Mus. Bull., 103, p. 611).

on the Pacific Coast; Kemp and Chopra (1921) have examined specimens from the Paris Museum collected at a depth of 15-25 m. at Espiritu Santo in the Gulf of California, and Hansen (1926) states that Dr. Th. Mortensen secured many specimens in the Gulf of Panama, thus confirming the previous records of Miers (1880) and Nobili (1897). According to Verrill (1923) it has been reported from West Africa by Benedict and Rathbun, but I am assured in a letter from Dr. W. L. Schmitt that this is an error, and it is not included in the list of West African species given by Monod (1925).

GONODACTYLUS OERSTEDII var. SPINULOSUS Schmitt

Gonodactylus oerstedii var. *spinulosus* Schmitt, Univ. Iowa Studies Nat. Hist., 1924, **10**, pp. 96-98, pl. 5, fig. 5.

Gonodactylus oerstedii (*pars*) Hansen, Siboga-Exped. Monogr., 1926, **35**, p. 27, fig. 104).

Diagnosis.—A variety of *Gonodactylus oerstedii* differing from the typical form in the following points: (1) the median spine of the rostrum is hardly long enough to reach the cornea, the anterior margins are nearly straight and transverse or slope backward, and the antero-lateral angles are rounded and depressed, not covering any part of the eye-stalks; (2) the telson bears numerous spinules on the dorsal surface, which are variable in position, but may be found upon the submedian central carinae, the anchor, the submedian marginal carinae, the accessory carinae, and not far from the margin of the telson near the apices of the median and intermediate notches; (3) the exopodite of the uropods is slightly longer than the basal prolongation and at least two of the mobile spines are distinctly recurved.

Discussion.—The diagnosis of this variety, not represented in the present collection, is introduced here because of its relation to var. *festae*. The type specimens were collected at Barbados by an expedition from the University of Iowa. A male specimen 34 mm. in length taken by the "Fish Hawk" at Playa de Ponce Reef, Porto Rico, in 1899, not distinguished from the typical form in the report on that collection (Bigelow, 1901), agrees in all essentials with the description of the type. Moreover, in the United States National Museum there are three females (No. 18,490) taken by the "Albatross" at station 2,758 off Cape St. Roque, Brazil, that are similar to the male from Porto Rico.

The characteristic black markings on the latter, described by Schmitt as resembling Chinese ideographs, are on the dorsum of the sixth thoracic and first abdominal somites, not on "the first and fourth

abdominal somites" as described for the type (*cf.* Kemp '13, fig. 1, p. 12; or Bigelow, '94, fig. 13). The mandibular palp is divided into three segments and in length equals more than a quarter of the carapace.

In the shape of the rostrum the typical form of the species appears to be intermediate between var. *spinulosus* and var. *festae*. In the specimen of var. *spinulosus* from Porto Rico the anterior margins extend nearly straight across to the antero-lateral angles, which are rounded and depressed. The three females, about 25 mm. long, from Cape St. Roque, have more obtuse angles, the anterior margins of the rostrum slanting distinctly backward.

On the telson of the male the three central carinae are much swollen and appear highly arched in lateral view. In the smaller females they are narrow and rounded, with a terminal spine, of which there is merely a trace in the male, on the median carina. There are slight variations in the number and arrangement of the spinules.

Distribution.— Barbados, *type*; coast of Brazil, "Albatross" station 2,758 off Cape St. Roque; Porto Rico, "Fish Hawk" Playa de Ponce Reef; Virgin Islands (?) and Gulf of Panama (?) Hansen (1926).

GONODACTYLUS OERSTEDII var. FESTAE (Nobili)

Gonodactylus chiragra Nobili, Bol. Mus. Zoöl. Anat. Univ. Torino, 1897, **12**, no. 280, p. 5.

Gonodactylus festae Nobili, Bol. Mus. Zoöl. Anat. Univ. Torino, 1901, **16**, no. 415, p. 53.

Gonodactylus chiragra var. *festae* Lancheester, Faun. and Geog., Maldives and Laccadive Arch., 1903, **1**, p. 456.

Gonodactylus festae Borradaile, Trans. Linn. Soc. (2) Zoöl., 1907, **12**, p. 219.

Gonodactylus festae Rathbun, Proc. U. S. Nat. Mus., 1910, **38**, p. 608.

Gonodactylus festae Kemp, Mem. Indian Mus., 1913, **4**, pp. 148, 153, p. 204.

Gonodactylus oerstedii (*pars*) Hansen, Siboga-Exped. Monogr., 1926, **35** (Livr. 104), p. 27.

Diagnosis.— A variety of *Gonodactylus oerstedii* having mandibular palps composed of three segments; dactylus of raptorial claw greatly inflated at the base and strongly flexed inward at the tip; rostrum with strong median spine, acute and extending to the cornea of the eyes, and antero-lateral angles of the rostrum produced into strong acute spines; sixth abdominal somite with six carinae terminating in spines; the telson has three central carinae, the median one with anchor flukes and all with or without terminal spines; submedian and intermediate

marginal teeth well developed, the lateral ones obsolete or absent; the dorsum of each submedian tooth bears a longitudinal carina, while the corresponding area of the intermediate teeth is occupied by a groove surrounded by two carinae, the inner (accessory) one being somewhat lower and shorter than the outer one, which forms an outwardly convex curve; the lateral margin is also carinate. The submedian and the accessory intermediate marginal carinae bear spinules on the dorsal surface.

General Description.—The collections of the Eastern Pacific Expedition of the "Albatross" contain a single specimen that may be referred to this variety. It is a female (E.P. 54) 34 mm. long, taken at Perico Island, Gulf of Panama, October 26, 1904 (Pl. 2, Fig. 3 and 4). This specimen and those described by Hansen (1926) are the only ones known in addition to the types collected by Dr. Festa and deposited in the museum of the University of Turin. Nobili's description of these is brief, but is sufficient to distinguish this form clearly from the typical forms of *G. chiragra* and *G. oerstedii*. It is like the latter in having an accessory carina on each intermediate marginal tooth of the telson, and it differs from both in having strongly produced acute lateral angles on the rostrum and in the presence of minute spinules on the marginal carinae of the telson. Nobili (1901) states that the spinules on the submedian marginal carinae are in two series.

Our specimen differs in that the submedian, like the accessory, marginal carinae bear only a single row of spinules. The intermediate marginal carinae are smooth. In this specimen the three central prominences are peculiar in shape (Pl. 2, Fig. 3). The base of each one is fairly broad, and is separated by a longitudinal groove on each side from the summit, which is narrow throughout and more or less angular or slightly produced at the posterior end. The grooves on the median prominence are bounded laterally by the flukes of the "anchor," and by low narrow ridges, one on each side, that connect the flukes with the two small tubercles, often observed in other species, lying close to the anterior end of the median carina. Below the posterior end of the median carina are two angular elevations, ending in minute posterior spinules. There are two well developed tubercles near the anterior margin of the telson, in line with the intermedian spines of the sixth abdominal somite. The eyes are cylindrical and rather large, the length of eye stalk being equal to 0.35 the length of the carapace. The ophthalmic somite is short and well covered by the rostrum; the dorsal processes are inconspicuous. The carapace is somewhat narrowed anteriorly; the anterior angles extend forward and are well

rounded; the posterior margin is nearly straight. The exposed thoracic and first five abdominal somites present no features of special interest. The latter have the usual carinae on the lateral margins which are rounded posteriorly.

The antennal scale is large, equalling half the length of the carapace. The propodus of the raptorial limb is moderately dilated at the distal end. The dactylus is evenly and very strongly inflated at the proximal end and the slender distal part is conspicuously inflexed.

The uropods are similar to those in *G. chiragra*. The basal prolongation is divided into two strong prongs, the longer outer one being unarmed and extending to the end of the exopodite. The basal segment bears a strong spine at the articulation of the exopodite. There is no spine guarding the articulation with the body.

Before the discovery of intermediate forms *G. festae* Nobili seemed clearly to be a species quite distinct from *G. oerstedii*. Reëxamination of the Porto Rico collection brought to light a specimen that had been overlooked. Its rostrum has rounded antero-lateral angles as in *G. oerstedii*, and its telson is spinulose as in *G. festae*. More recently Schmitt (1924) has described very similar specimens from Barbadoes under the name *G. oerstedii* var. *spinulosus*, as noted above (p. 123). We must, therefore, agree with the opinion of Hansen (1926), based on the study of specimens from the Virgin Islands and the Gulf of Panama in European museums, that *G. festae* is a variety of *G. oerstedii*.

Color.—The only indications of color pattern in our alcoholic specimens are a large number of minute black spots that show an irregular tendency toward bilateral symmetry in their arrangement. There is a row of three irregular clusters on the carapace, and a loose cluster on the middle of the sixth thoracic and the first abdominal somites, and scattered spots on these and other segments.

Distribution.—The present specimen was taken at Perico Island, Gulf of Panama. Nobili (1901) records the discovery of this variety at Darien and on the coast of Ecuador at Punta St. Elena and Baia de St. Elena. He explains (1897, p. 6) that specimens labeled "Darien" by Dr. Festa were taken in San Miguel Bay, Gulf of Panama, not in the Gulf of Darien on the Caribbean side of the Isthmus, as might be supposed. At least one of the spiniferous specimens described by Hansen (1926, p. 27) appears to belong to this variety, but he does not state whether it was taken at the Virgin Islands or in the Gulf of Panama.

Table of Measurements

Specimen No. E. P. 54	♀	mm.	ratio
Length median line, total length		33.0	
Length rostrum		2.7	
Ratio length of rostrum to total length		—	0.08
Ratio width to length of rostrum		—	1.00
Ratio length of carapace to total length		—	0.25
Ratio anterior width to total length		—	0.15
Ratio width fifth abdominal segment to total length		—	0.20
Width telson		6.0	—
Ratio maximum length telson to total length		—	0.15
Ratio maximum length telson to width of telson		—	0.80
Ratio depth of telson to width of telson		—	0.48

GONODACTYLUS GLABROUS Brooks

- Gonodactylus glabrous* Brooks, Voy. H. M. S. "Challenger," Zoöl., 1886, **16** (45), p. 62, pl. 14, fig. 5; pl. 15, fig. 7, 9.
- Gonodactylus glaber* Henderson, Trans. Linn. Soc. Zoöl., (2), 1893, **5**, p. 454.
- Gonodactylus glabrous* (incl. var. *ternatensis*) de Man, Abh. Senck. Nat. Ges. Frankfurt, 1902, **25**, pp. 913-914, pl. 27, fig. 67.
- Gonodactylus chiragra* var. *glabrous* and var. *mutatus* Lanchester, Fauna and Geogr. Maldive and Laccadive Arch., 1903, **1**, pp. 448, 451, pl. 23, figs. 8, 9, 15.
- Gonodactylus graphurus* Nobili, Bull. Sci. France et Belg., 1906, **40**, p. 159.
- Gonodactylus glaber* (incl. var. *ternatensis* and var. *rotundus*) Borradaile, Trans. Linn. Soc. Zoöl., (2), 1907, **12**, pp. 211, 212.
- Gonodactylus chiragra* var. *glabrous* Balss, Denk. Math.-Nat. Kl. K. Akad. Wiss. Wien., 1910 (1912), Reprint (1910) of **87**, Fortsetzung . . ., pp. 31-32, fig. 5.
- Gonodactylus glabrous* Kemp, Mem. Indian Mus., 1913, **4**, pp. 167-169, 197-198; pl. 9, fig. 113 and text fig. 2, p. 170 (incl. complete bibliography to 1910).
- Gonodactylus glabrous* Bouvier, Bull. Sci. France et Belg., 1915, **48**, p. 313.
- Gonodactylus glabrous* Kemp, Philip. Jour. Sci. (D), 1915, **10**, pp. 182-183.
- Gonodactylus glabrous* Alexander, Jour. and Proc. Roy. Soc. W. Australia, 1916, **1**, p. 10.
- Gonodactylus glaber* Tattersall, Jour. Linn. Soc. Zoöl., 1921, **34**, p. 362.
- Gonodactylus glabrous* Parisi, Atti Soc. Ital. Sci. Nat., 1922, **61**, pp. 112-114, fig. 7.
- Gonodactylus glabrous* Odhner, Göteborgs Vet. Handl., (4), 1923, **27**, (4), p. 8.
- Gonodactylus glabrous* Hansen, Siboga-Exped., 1926, **35**, pp. 29-30.
- Gonodactylus glabrous* Komai, Mem. Col. Sci., Kyoto Imp. Univ., (B), 1927, **3**, p. 340.

Diagnosis.—A *Gonodactylus* of Group I, having on the dorsum of the telson a central eminence bearing five longitudinal carinae, of which the outer pair (second submedian) is the smallest; lateral marginal teeth distinct and acute; first five abdominal somites smooth except for a distinct pit on each side near the customary L-shaped groove; carapace with sides nearly straight and parallel, and nearly straight gastric grooves diverging from the anterior to the posterior margins, so that the lateral portions of the carapace are rhomboidal; dorsal processes of the ophthalmic somite small and rounded; raptorial propodus without movable spine, the dactylus moderately inflated at the base and the slender distal part strongly flexed, the tip usually with a distinct reversed curve, frequently marked on the outer margin by a distinct, although minute, angle; the basal process of the uropods with a small denticle on the inner side of the outer spine near its base; the proximal segment of the exopodite with two sharp longitudinal carinae, of which the inner is slightly shorter than the median one; the outer margin also carinate, the endopodite with a sharp longitudinal carina near the outer margin, which is upturned so that the fringe of setae on this side point upward nearly at a right angle to the fringe on the inner side.

General Description.—Lanchester (1903) regards this species as a variety of *G. chiragra*. The basis for this view is the fact that in certain small specimens of *G. chiragra* the anchor flukes were found to be separate from the median carina of the telson, and thus seemed to present an intermediate condition (var. *segregatus*). Lanchester relies entirely upon the variability of the central carinae. I quite agree with Kemp (1913) that in reality there is no justification for uniting the two species on this ground. No specimen has come under my observation which could not be classified in one or the other of these species by characters of the telson alone. In specimens of all sizes of *G. glabrous*, the submedian carinae of the telson are sharply separated from the median one and are longer and more elevated than the outer, or second submedian, pair; and the lateral marginal teeth are always sharply defined. But even if the telson were destroyed, there are numerous other differences by which the species can be recognized. Some of these have been noted by Kemp. He states that *Gonodactylus glabrous* differs from *G. chiragra* only in the following characters:

1. The small size and rounded margin of the dorsal processes of the ophthalmic somite.
2. The absence of the small movable spine on the raptorial propodus.

3. The presence of a rather conspicuous pit on the side near the anterior margin of the 2d, 3d, 4th, and 5th abdominal somites.
4. There are *five* long carinae in the middle of the dorsal surface of the telson, and immediately behind the median there is a small pair of tubercles. The lateral marginal teeth are more distinct than in *G. chiragra*.
5. There is a small denticle on the outer spine of the basal process of the uropods.

The small tubercles referred to in paragraph 4 are, I suppose, a pair situated on a curved elevation which is separated from the median carina by a deep groove. There is also a pair of tubercles on the posterior end of the median carina in the position of the flukes of *G. chiragra* and separated from the spine by a pit. Similar pits occur under the spines of the submedian carinae of the telson and under the submedian and intermediate spines of the 6th abdominal segment. Under the intermediate spines of the sixth somite and the submedian of the telson the pit is not symmetrical with the axis of the spine but is on its median side, and on the telson the outer border of the pit is usually elevated into a small tubercle which may be considerably elongated in a curved direction behind the spine. These points are not clearly shown in the otherwise excellent figure by de Man (1902, pl. 27, fig. 67). I may add that in practically all of the specimens that I have examined there are well developed spines on all six carinae of the sixth abdominal somite and on the three central ones of the telson. Where spines were absent, careful examination has generally shown that they were broken off. In *G. chiragra* there is frequently no trace of spines on the central carinae of the telson, and I have seen no indication of the pits beneath the spines.

There are a number of other differences between *G. glabrous* and *G. chiragra*. Some of them have been mentioned in the diagnosis above. On the telson of *G. glabrous* the tubercles near the anterior margin are more conspicuous, often appearing as "sharply defined carinae" (Brooks). The lateral marginal teeth are very distinct and acute in all my specimens, the notch on the inner side of this tooth generally being deep and bordered by a well defined elevation of the margin.

The uropods of *G. glabrous* present striking peculiarities that seem to have escaped notice. The endopodite has a complete fringe of setae, but this does not lie flat as in *G. chiragra*. On the contrary, the whole outer edge of this segment is turned sharply upward and the setae inserted in this part point dorsally, nearly at a right angle to the fringe on the inner edge. Also, on the dorsal surface there is a sharp longitudinal

carina close to and parallel with the outer margin. In *G. chiragra* the corresponding position is occupied by a low, rounded thickening and the margin is not at all upturned, or very slightly so, at the proximal end.

In the uropods of *G. chiragra* the proximal segment of the exopodite has a single longitudinal dorsal ridge, and there is on the inner side a slight rounded elevation which in small specimens may be carinate for a short distance near the proximal end of the segment. In *G. glabrous* of all sizes this inner carina is well developed, so that there are on this segment two sharp longitudinal ridges of which the inner one is only slightly the shorter. There may be also a sharp thickening of the outer margin, which is not present in *G. chiragra*. The terminal fixed spine is very short in *G. chiragra*; in *G. glabrous* it is half as long as the distal mobile spine. In both species the terminal movable spine is straight and reaches to about the end of the terminal segment, but in *G. chiragra* the two or three spines next to the terminal one are more or less recurved and flat, while in *G. glabrous* they are not at all recurved but are, with the rest of the series, distinctly curved upward toward the tips.

Equally striking are the differences in the carapace. In the typical form of *G. chiragra* the carapace is narrowed anteriorly with nearly straight sides and straight gastric grooves running parallel to the sides. In var. *platysoma* the sides of the carapace are not straight but bend inward at the anterior third, and the gastric grooves are not straight but are bent outward at the cervical node. In *G. glabrous* the sides of the carapace are nearly straight and parallel to each other, and the gastric grooves are also nearly straight but not parallel to the sides, which they approach posteriorly, so that the lateral areas of the carapace gradually become narrower from the anterior margin backward.

The tip of the raptorial dactylus is rather variable. In some specimens from the Philippines it is practically of the same form as in *G. chiragra*. In others from that region, and in practically all from Samoa it is of the form to be seen in Figure 1. There is a pronounced outward turn to the point, and on the outer surface the point of inflexion is marked by a distinct angle. The tip is frequently broken, which gives a deceptive appearance.

There is great variation in the rostrum. In some specimens the median spine reaches to the cornea of the eyes, in others it is so short as to barely overlap the base of the eye-stalk. In the form of the lateral angles there is a nearly constant difference between specimens from Samoa and those from the Philippines. In the Samoan specimens the

maximum length of the rostrum is generally considerably greater than the width at antero-lateral angles. The anterior margins on each side of the spine are nearly transverse and the antero-lateral angles are broadly rounded. In the Philippine specimens the length and breadth are about equal, the anterior margins are usually directed obliquely forward from the junction with the spine and the antero-lateral angles are narrowly rounded or subacute.

According to Kemp the only characteristic by which this species can be distinguished from the closely related *G. graphurus* Miers is the absence of transverse and longitudinal grooves on the sides of the first five abdominal somites (Brooks 1886, pl. 414, fig. 1 and Kemp, 1913, p. 170, text figs. 1 and 2). I too have found no indication of these grooves in any specimen I have examined. On the other hand, they



FIG. 1.—*Gonodactylus glabrous* Brooks, female, 58 mm., from Apia coral reef (No. 15a). Raptorial limb (right), showing the dactylus of the typical Samoan form with an outward turn at the apex and an angle at the point of inflection. Length of dactylus, 9.05 mm.

were perfectly constant in numerous specimens of *G. graphurus* examined by Pocock (1893, p. 475), except in one very small (10 mm.) individual. Brooks states that in *G. glabrous* the paddles of the exopodites of the uropods are less than half as long as the second joint. They are longer in my specimens. The proportions of length to breadth of the telson are variable. Some of the other characters that Brooks mentions as distinctive are sexual. He described the species from a single female specimen.

There is considerable variation in the sculpturing of the sixth abdominal somite and of the telson, including an evident sexual dimorphism. In all specimens the submedian and intermediate carinae of the sixth abdominal somite are triangular in outline, the apex terminating in the strong posterior spine. The upper surface of these carinae is more or less flat, and slopes forward to the general surface of the somite

just behind a prominent transverse ridge that borders the whole of the articular membrane, and is not completely covered by the posterior edge of the somite in front, even when the abdomen is fully extended. The lateral carinae of the sixth abdominal are narrow, and in females, flattened on top. All the carinae of the telson are more or less rounded above. In young specimens of both sexes less than 35 or 40 mm. in length the carinae are generally narrow and sharp, each ending in a strong spine, and there is no sexual dimorphism. In larger specimens of both sexes there is a tendency toward a broadening of the carinae, with a decrease in the proportionate size of the terminal spines. This tendency is most conspicuous in the males. In a typical adult female over 35 mm. long, the carinae of the sixth abdominal somite are distinctly flattened on the upper surface, which makes a sharp angle with the steep sides. The central carinae of the telson also have steep sides and the valleys between, as seen in posterior view, are wider than the carinae. In a typical male the submedian carinae of the sixth abdominal somite are rounded on top, and on all the carinae of this somite the angles are more rounded than in the female. All the carinae of the telson are broader and more rounded than in the female. The central carinae are much swollen with sloping sides, and the valleys between, as seen from behind, are not wider than the carinae.

There is considerable variation in both sexes. In females of the same size, some will have the central carinae of the telson sharp and narrow (Brooks, 1886, pl. 14, fig. 5) and others will have broader ones (de Man, 1902, fig. 67). Some males have central carinae differing little from the maximum in the females; in other individuals of the same size, they are much broader and swollen, although the maximum tumidity in the females approaches the minimum of the males. I have not found a single pair of individuals of equal size in which the difference could not be detected with more or less ease. Balss (1910*b*) has found a sexual dimorphism in the color pattern (see below).

Several authors have attempted to divide *G. glabrous* into varieties based on differences in the sculpturing of the telson. De Man (1902) founded the var. *ternatensis* on a female with broader form of carinae. Lanchester (1903) recognized that in this species, which he regards as a variety of *G. chiragra*, there is continuous variation, but he failed to notice the effects of age and sex. For his "term *a*," minimum tumidity, he refers to the specimen described by Brooks, a female. His "term *b*," maximum tumidity, is a male (Lanchester, pl. 23, fig. 15). None of my specimens shows so high a degree of tumidity as is represented by his figure of this specimen. According to my view "term *b*♂" would

be very different from "term *b* ♀", which is accurately illustrated by his Figure 8, and corresponds exactly to de Man's var. *ternatensis*. He separates as var. *mutatus* a number of small specimens of both sexes from the Maldivé Archipelago. All of these are under 40 mm. long, all but two under 31 mm., and yet the "carinae are very swollen", whereas all my specimens under 30 mm. long have very narrow carinae. This suggests that in var. *mutatus* we may have a distinct dwarf variety, such as I have reason to think may occur in *G. chiragra*. Borradaile (1907) has divided the species into two varieties: (1) var. *ternatensis* de Man, 1902 (= *ternatensis* de Man + *glaber* type de Man = *mutatus* Lanchester + *glaber* (*pars*) Lanchester) — carinae narrow or of moderate width, not touching one another, spines present at the ends of the three middle carinae of the telson; (2) var. *rotundus* Borradaile (= *glaber* (*pars*) Lanchester) — carinae broad and swollen so as to touch one another, spines of the three middle carinae of the telson obsolete or absent. In Cambridge University Museum there were, at the time of my visit, three specimens labeled "*Gonodactylus glaber* var. *rotundus* Borr. cotypes." These were all males, 40, 41 mm. from Coetivy, 33 mm. from Zanzibar. There were also seventeen specimens labeled by Borradaile "*G. glaber* type var.", or "*G. glaber* var. *ternatensis* de Man (Borradaile, 1907)." These were all females, with the exception of three small males, 36, 28.5, and 22 mm. long. Borradaile's illustration of var. *tumidus* (1907, pl. 22, fig. 2) is surprising when compared with my specimens, none of which has anything like the broad, rounded intermediate teeth on the telson shown in that figure. If the figure be correct it may represent a distinct variety. Kemp (1913) notes the high degree of variability in this species, but states (p. 154) that there can be no doubt that the variation is continuous, and he urges the same objections as in the case of *G. chiragra* to the use of special names to designate particular varietal phases. He observes that among the Ceylon specimens, which form the vast majority of those he examined, "a spineless form with moderately or greatly swollen keels seems to preponderate." As stated above, nearly all the specimens that I have examined from Samoa and the Philippines have spines on the three middle carinae of the telson, and the carinae are narrow or moderately swollen.

Color.—Kemp (1913) reports that his specimens from Ceylon, preserved in formaldehyde and examined not long after capture, showed great variation in color. "The commonest shade was a uniform olivaceous yellow, while other examples were dull purple, deep purplish green profusely mottled, dark olive, olive brown with pale marbling,

brick red, or dull orange. On the last abdominal segment a pair of very small black spots were constantly found close to the anterior margin, situated one on either side, between the submedian and intermediate keels. The keels in this somite and on the telson were in most cases defined by a darker tone." My specimens likewise show evidence of great variation in color and pattern, although preserved in alcohol. The black spots on the sixth abdominal somite, noted by Kemp, are almost invariably present, and in addition there are usually two similar spots on the telson anterior to the second submedian carinae, as observed by de Man (1902, p. 914). Balss (1910 *b*) finds constant differences between the color pattern of the two sexes in a large collection from the Red Sea. The males are spotted with black, while the females are quite clear.

Distribution.—All the specimens in the present collection were obtained at Apia, Samoa—one lot at least from the outer coral reef. This appears to be the first record from Samoa, but the species is a common one, distributed widely in shallow water throughout the Indo-Pacific region. The type locality is Zamboanga, Philippine Islands, and Kemp (1915) records this species from a number of localities in that region. From there it extends north to Misaki in southern Japan (Komai, 1927). The Siboga Expedition (Hansen, 1926) found this species on the coral reefs and down to 59 meters at twenty-one stations in the Dutch East Indies, from Lombok in the west to the Aru Islands in the east, and from the south coast of Timor to North Ubian in the Sulu Sea. Alexander (1916) reports it from Sharks Bay, Western Australia, and Bouvier (1915) from Mauritius. Kemp (1913) gives a long list of stations in the Indo-Pacific region at which specimens have been taken, from Rotuma in the east, westward and south to Ibo in Portuguese East Africa. Odhner (1923) reports it from Fiji, the Gilbert, Marshall, and Bonin Islands, where it is often the most abundant stomatopod. Tattersall (1921) says that it is the commonest stomatopod in the Red Sea. According to Kemp (1913) it is the only species of *Gonodactylus* of which there is an authentic record of occurrence in the Mediterranean, Steuer (1911, p. 734) having found specimens in Heller's collection obtained at Lesina in Dalmatia. The doubt expressed by Hansen (1926) as to the correctness of this locality may be unwarranted in view of the statement by Parisi (1922), that four specimens in the Milan Museum, collected at Nice by C. Bellotti about 1885, confirm absolutely the presence of this species in the Mediterranean.

Habitat and Breeding Habits.—The majority of collections are re-

ported from coral reefs. On the Ceylon pearl banks in the north of the Gulf of Manaar, where this species occurs in profusion, vastly exceeding *G. chiragra* (Kemp, 13, p. 169), the specimens were for the most part found in crevices and holes in coral blocks. Many females with egg masses were found, and the breeding habits of this species appear to be similar to those of *G. oerstedii* observed by Brooks, but the evidence appears to be against the view that the female digs her own burrow (Kemp, 1913, p. 197-98).

Size.—The largest specimens in the present collection are a male 52 mm. and a female 66.5 mm.; the smallest is a female 20 mm. long. Hansen's largest specimen measured 78 mm. Kemp reports a range in size from 14.5 to 98 mm.

List of Specimens

All from Apia, Samoa

No.	Sex	Length
15a	♀	58.0 mm.
15b	♂	46.0
15c	♂	52.0
15d	♀	45.0
15e	♀	48.3
15f	♀	41.0
15g	♀	39.5
15h	♀	37.0
15i	♀	38.5
16a	♀	66.5
16b	♂	47.5
16c	♀	53.5
17	♂	42.0
18a	♀	57.5
18b	♀	39.0
18c	♀	20.0
19	♀	47.5

GROUP III, Kemp, p. 146

Diagnosis.—Anterior margins of the carapace not sloping forward, antero-lateral angles not in advance of the rostral base; rostrum typically trispinous; mandibular palp with two segments; posterior margin of 6th abdominal somite concave¹ in dorsal view; proximal

¹ Kemp, '13, p. 148. The word "convex," *ibid.*, p. 146, is a slip of the pen.

segment of the exopodite of the uropod articulates terminally with the ultimate segment, and on its outer edge is armed with straight movable spines, endopodite normal.

Type Species.— *G. trispinosus* Dana.

Species Represented in the Collection.— *Gonodactylus glyptocercus* Wood-Mason; *Gonodactylus guerinii* White.

GONODACTYLUS GLYPTOCERCUS Wood-Mason

Gonodactylus glyptocercus Wood-Mason, Proc. As. Soc. Bengal, 1875, p. 232; reprinted (1876) in Ann. Mag. Nat. Hist. (4), **17**, p. 263.

Protosquilla cerebralis Brooks, Voy. H. M. S. "Challenger," 1886, **16**, Stomatopoda, p. 72, pl. 14, figs. 2, 3; pl. 16, figs. 2, 3.

Protosquilla glyptocerca Brooks, *ibid.*, 1886, p. 75.

Protosquilla cerebralis Borradaile, Proc. Zool. Soc., 1898, p. 33, pl. 5, fig. 6a.

Protosquilla cerebralis Fukuda, Annot. Zool. Japon., 1910, **7**, p. 139.

Gonodactylus glyptocercus Kemp, Mem. Indian Mus., 1913, **4**, p. 186 (*ubi syn.*).

Gonodactylus glyptocercus Kemp, Philippine Jour. Sci. (D), 1915, **10**, p. 186.

Gonodactylus glyptocercus Kemp and Chopra, Rec. Ind. Mus., 1921, **22**, p. 311.

Gonodactylus glyptocercus Odhner, Göteborgs Vet. Handl. (4), 1923, **27**, (4), p. 13.

Gonodactylus glyptocercus Hansen, Siboga Exped. Monogr., 1926, **35** (Livr. 104), p. 36.

Gonodactylus glyptocercus Komai, Mem. Col. Sci. Kyoto Imp. Univ. (B), 1927, **3**, p. 341.

Diagnosis.— A *Gonodactylus* of Group III (Kemp) with large cylindrical eyes, corneal portion very slightly dilated, hemispheroidal; dorsal processes of the ophthalmic somite large and hood-shaped; dactylus of the raptorial limb strongly swollen at the base; rostrum sharply trispinus with lateral spines curved forward; carapace nearly quadrate, its breadth about two-thirds the length; dorsal surface of hind body smooth, except the fifth and sixth abdominal somites and telson, which exhibit a bilaterally symmetrical pattern of fine grooves, low ridges, and rounded bosses peculiar to the species. The pattern on the fifth abdominal somite consists of two parallel longitudinal grooves near the median line, and on each side ten or twelve irregular longitudinal grooves frequently bifurcated, running on the dorsum obliquely posterior-dorsally and on the sides curving ventrally. The sixth abdominal somite is very short in the median line and is firmly fused to the telson, the boundary between the two being marked by a groove that is strongly convex anteriorly. The dorsal surface is covered by convoluted rounded ridges, higher than on the fifth somite. Of these a

submedian pair of U-shaped and an antero-lateral pair of ∞ -shaped ridges are most conspicuous. The telson has three central bosses, a median one, subtriangular in outline, and two submedian oval ones. All have moderately high, smooth, rounded summits and on the sides fine grooves running upward from the narrower furrows that bound them, except on the posterior ends whence low ridges extend to the margin of the telson. On each side between the central elevations and the lateral margin are four blunt longitudinal ridges, the marginal one being grooved in its anterior half. The telson is wider than long, and has a very deep and narrow median fissure, the sides touching; has three pairs of broad marginal teeth, acute at the apex; a slender mobile spinule about three times as long as the denticles on the submedian tooth and articulated on the margin between the distal one of this series and the apical portion. Denticles, 9-11, 1, 1. Basal process of the uropods divided into two spines, the inner one more than half the length of the outer; proximal segment of the exopod bears 8-10 movable spinules.

General Description.—This species was first adequately described and figured by Brooks (1886) under the name *Protosquilla cerebialis*. He suggests, however, that it may be identical with *Gonodactylus glyptocercus*, briefly described by Wood-Mason (1875). Kemp (1913) has compared the figures and description given by Brooks with Wood-Mason's type specimen, and finds the identity to be complete. The reason for rejecting the generic name *Protosquilla* has been discussed on a previous page.

This seems to be a small species. Of the eleven specimens collected by the "Albatross" at Pago Pago the largest, a female, is 28.7 mm. in length from the tip of the rostrum to the end of the telson, the largest male is 22.5 mm. in length. The specimen from Fiji described by Brooks was 32.3 mm. long, while in the collection in the Indian Museum the range is from 10.5 to 29 mm. Hansen (1926) reports that the largest specimen taken by the Siboga Expedition is 35 mm. long.

The specimens in the present collection agree in all essential features with the description given by Brooks and emended by Fukuda (1910) and by Kemp (1913).

They differ in some minor details. The eyes appear to be larger. Measured from the tip to the outer margin of the base, they are nearly half as long as the carapace. The median spine of the rostrum does not reach half the length of the eye-stalks, but only a little beyond the inner margin of the base.

Between the rostrum and the bases of the eye-stalks are the con-

spicuous dorsal processes of the ophthalmic somite. These are hood-shaped; the arched anterior margins appear nearly transverse in dorsal view, and touch the rims of the base of the eye-stalks when the eyes are raised. Their antero-lateral angles are acute.

Brooks describes the carapace as a little longer than wide, while according to Kemp its length in the median line is more than one and one half its breadth at the antero-lateral angles. In one specimen the anterior width is on the average seven-tenths of the length.

Kemp notes that the outermost of the spinules (denticles) on the convex margins between the submedian teeth of the telson are larger than the rest. In reality these larger spinules, which are three times as long as the true fixed denticles, do not belong in that series. They are movably articulated to the margin or slightly under it on the ventral side, and are similar to mobile spinules found in a similar position in several species of *Lysiosquilla*. They may be characteristic of Group III of the genus *Gonodactylus*. In addition to these, the submedian teeth have minute mobile tips. In our specimens the tips of the other teeth are also soft and turned upward. If this represents the condition in life, it suggests a sensory function.

On the exopodite of the uropod, I find nothing to suggest the curved line of spinules mentioned by Brooks. The arrangement of the mobile spines on the proximal segment is quite normal. At the distal end of this segment there is a fixed spine half as long as the distal mobile spine.

Color.—In their color pattern the specimens in the collection divide themselves into two groups as described by Kemp. A majority of them are pale with scattered stellate black pigment cells distributed generally over the surface, but absent on the dorsal surface of the sixth abdominal somite and telson, on the dactylus of the raptorial limb, and on the distal parts of antennae and walking legs. The complete pattern consists also of a series of median patches of dark pigment, single or paired, on the sixth and seventh thoracic and first and fourth abdominal somites, and a lateral patch on each side of the sixth thoracic. One or more of the median patches may be absent. In the smaller group pigment cells are absent on the dorsal surface of the sixth abdominal somite and the telson and the other parts mentioned above. The rest of the body is uniformly dark mottled brown. There is no correlation between these differences and sex. No record has been made of the color of the living animals.

Distribution.—On the South Pacific Expedition of the "Albatross" in 1902 there were taken during July and August four males and seven females, all at Pago Pago, Samoa. This is the most eastern record for

the species. On the west it has been taken at the Nicobars (*type*, Wood-Mason) and at the Andamans and the Mergui Archipelago (Kemp, Kemp and Chopra). It ranges north to Okinawa, in the Kiu Kiu Islands of Japan (Fukuda, Komai), and south to the Loyalty Islands (Borradaile). Between these points there are records from the Java Sea (de Man, Odhner); in the Molucca Passage at Ternate (de Man) and at Siau and Salibabu Islands (Hansen); at Mindoro, Philippines (Kemp); New Britain and Rotuma (Borradaile); Gilbert Islands (Odhner); and Fiji (Brooks, Odhner).

Size.— The four males in the collection vary from 20.5 to 22.5 mm. in length, and the seven females, from 19.8 to 28.7.

GONODACTYLUS GUERINII White

Gonodactylus guerinii White, Proc. Zoöl. Soc. Lond., 1861, p. 43, pl. 7; and Ann. and Mag. Nat. Hist. (3), 7, p. 480.

Gonodactylus guerinii Miers, Ann. and Mag. Nat. Hist. (5), 1880, 5, p. 121.

Protosquilla guerinii Brooks, Voy. H. M. S. "Challenger," 1886, 16, Stomatop., pp. 75-78, pl. 16, figs. 1, 6.

Gonodactylus guerini Kemp, Mem. Indian Mus., 1913, 4, pp. 192-93.

Gonodactylus (Protosquilla) guerinii Bouvier, Comptes Rend. Acad. Sci., 1914, 159, p. 698.

Gonodactylus (Protosquilla) guerini Bouvier, Bull. Sci. de la France et de la Belgique, 1915, 48, p. 313, pl. 7, fig. 10.

Gonodactylus (Protosquilla) guerini Carrié, Bull. Mus. National d'Hist. Nat., 1915, 21, p. 151.

Gonodactylus guerinii Edmondson, Occ. Papers, B. P. Bishop Mus., 1921, 7, pp. 299-300, fig. 1g.

Gonodactylus guerinii Gravier, Bull. Mus. Nat. d'Hist. Nat., 1928, 34, pp. 337-340, figs. 1-3.

Diagnosis.— A *Gonodactylus* of Group III (Kemp) having eyes with compressed transverse cornea; dorsal process of ophthalmic somite erect, with obtuse angles in line with axis of eye; mandibular palp present; dactylus of raptorial limb evenly dilated at base, distally slender and curved, rostrum sharply trispinus, the median spine reaching half the length of the eyes; carapace flattened, its posterior width equal to its length, narrower anteriorly, antero- and postero-lateral angles rounded; first to fifth abdominal somites with L-shaped marginal carinae, fifth abdominal somite with anterior half nearly smooth, posterior half armed with small vertical spines arranged in 3-5 transverse rows parallel with the concave posterior margin, also two rows of similar spines on articular membrane; sixth abdominal somite and

telson fused into one piece armed with tall, slender, vertical, and outward slanting spines with soft tips, the central ones arising from three inconspicuous tubercles in the central area of the telson; anterior margin of telson defined by distinct grooves on dorsal and ventral sides, at posterior end four marginal teeth fringed with spines and separated by three deep fissures, the depth of the median fissure being more than half the total length of the telson; basal segment of uropod and endopodite, each with a longitudinal row of fixed spines on dorsal surface; basal process strongly convex laterally, its stout outer spine twice the length of the slender inner one, and reaching nearly to or beyond the tip of the exopodite, distal segment of the exopodite less than half the length of the proximal segment which is armed with eight or nine stout movable spines.

General Description.—It is remarkable that the only known examples of this beautiful species were found in such widely separated localities as Fiji, the Hawaiian Islands, Mauritius, and the Marquesas Archipelago. Although widely distributed, the species is rare in collections. Perhaps this rarity may be explained by its habits. The only information as to its habits that we have is furnished by a note addressed by M. Paul Carrié (1915) to the Musée Nationale d'Histoire Naturelle. He quotes a note of M. Thirioux, who discovered the species in Mauritius and furnished the specimen that was described by Bouvier (1915). M. Thirioux says of this species, known to him for twenty years, that it is found living among the corals at a depth of five to ten feet. When it wishes to rest or to flee from danger, it enters a cavity in the coral, which it has chosen, and blocks the entrance with the spiny shield on the terminal segments of the abdomen, "ce qui fait que le naturaliste croit avoir devant lui un petit ursin et ne pousse pas plus loin ses investigations." M. Carrié does not know the color, but suggests that probably it is the same as that of a little greenish sea-urchin, *Echinometra lucuntur* L., that is very abundant on the corals and strikingly resembles this part of the animal.

The terminal shield, consisting of the fused sixth abdominal somite and telson reinforced by the stout uropods, is indeed the most striking feature of the animal, and at once distinguishes the species from all others. It is well illustrated by Brooks (1886), and Bouvier (1915) gives an excellent photograph of it. In the hand, it suggests a composite flower, rather than a sea urchin.

Gravier (1928) criticises the drawing of Brooks (pl. 16, fig. 1) as imperfect. It shows, however, the arrangement of the spines as seen in our specimens, and corresponds in all essentials to the photograph given

by Bouvier (pl. 7, fig. 10). Gravier states that in his specimens the spines are longer and more thickly set than shown by Brooks, and his Figure 1 does give a better idea of the size and form of the spines. The photograph from which the drawing was made, however, was taken at an angle that does not give a view of their arrangement. From a study of the soft tips of the spines when stained and cleared, Gravier concludes that they are cuticular in structure and each is penetrated by a minute canal that opens at the apex. He found also, on the posterior part of the telson, some spines with bifurcated tips.

In our specimens the spines with soft tips are arranged on the dorsal surface in two series. The outer series consists of a double row shaped like a horseshoe. Beginning in the middle of the sixth abdominal somite it extends on each side to and along the lateral margin of the telson to the tips of the converging outer pair of marginal teeth. The space covering the articulation of the uropod between this double row of spines and the antero-lateral angles is densely covered by small spines. The central area is approximately circular in outline, and is occupied by twenty-two tall, straight, slender spines, evenly spaced and symmetrically arranged in two concentric circles around a central pair. They are nearly vertical with an outward obliquity proportionate to the distance in any direction from the center. Upon examination with a binocular microscope, it may be seen that these spines arise from three prominences that are slightly elevated, but are separated by distinct grooves. The median elevation is ovate or kite-shaped in outline with its short axis near the anterior end, the other two are nearly elliptical with their long axes convergent posteriorly, suggesting comparison with *G. glyptocercus*. At each end of the median elevation there is a median spine, and between there are three pairs, the spines of the anterior pair being the most widely separated from each other, and with the anterior median spine forming part of the outer circle. Each of the submedian elevations bears two spines of the inner circle and five of the outer circle, the posterior spine on each one being in line with the axis of the adjoining submedian marginal tooth. The line separating the telson from the sixth abdominal somite is marked by a sharp groove bordered by rounded folds, and it curves anteriorly around the outer circle of central spines. The three posterior marginal fissures of the telson are fringed with a single series of horizontal spines, their acute points being directed obliquely backward, and interlacing with their fellows of the opposite side.

Between the tergites of the fifth and sixth abdominal somites the articular membrane is thrown into two transverse inward folds. The

outward fold between them bears two rows of small spinules. In our largest specimen the body is bent at this joint so that the terminal shield, as seen from one side, makes an angle of about 108° with the abdomen, and the somites seem to be firmly fixed in this position. Brooks states that in the Challenger specimen the fifth and sixth abdominal somites are fused, but in our two smaller specimens the joint between these somites is perfectly flexible. On the posterior half of the fifth abdominal tergite is a semilunar area covered with small erect spinules arranged in three or five rows parallel to the posterior margin. The spinules of the anterior row incline forward, and those in the posterior row in the opposite direction. The anterior half is not entirely smooth, neither is it separated from the spinous portion by a distinct groove. The surface is symmetrically uneven with very irregular shallow depressions. On each side near the hinge there is a slight elevation divided unequally by a longitudinal groove, and between this elevation and the smooth marginal carina there is a short longitudinal carina bearing spinules.

The uropods are robust, protecting the delicate marginal spines of the telson. On the dorsal surface of the basal segment are two or three erect spinules, and the spine over the articulation is unusually stout and blunt. The basal prolongation is broad and blade-like, outwardly convex, curved, and twisted downward, so that its two spines lie nearly in a vertical plane, and give firm support to the exopodite. When folded inward, this part of the limb fits snugly upon the upper or outer surface of the process, the row of eight or nine stout movable spines pointing downward along its outer edge, and the tip of the distal segment extending nearly to or slightly beyond its outer spine. The articulation of the distal segment of the exopodite is terminal on the proximal segment, and has a small fixed spine on the ventral side. On the dorsal surface of the endopodite there is a longitudinal row of four or five generally sharp spinules. The fringe of marginal setae is complete on all the segments.

This species has a number of other peculiar features. The corneal portion of the eyes is compressed so that the long axis of the cornea, which is directed obliquely in a ventro-lateral direction, is twice the length of the shorter axis and about two-thirds as long as the peduncular axis. The propodus of the raptorial limb is finely serrate on the outer edge of the groove, and the dactylus is also finely serrate. In our smaller specimens the rostrum covers the ophthalmic somite as in Brooks's figure. In the larger specimen, on the other hand, the dorsal processes of this somite are easily seen in the angles between the median

and lateral spines. Their erect points can touch the margin of the base of the eye-stalk over the middle of the articulation. The scale at the antero-lateral angles of the first abdominal somite is unusually small. The dorsal surface of the carapace, exposed thoracic, and first four abdominal somites are without features of special interest. Edmondson (1921) has figured the endopodite of the first abdominal limb of the only known male.

Color.— There is no record of observations of the color of the living animal. Our largest specimen, when received for examination, was preserved in formaldehyde and presented the most striking appearance. The telson and sixth abdominal somite were whitish with their spines tipped with crimson. All the rest of the dorsal surface, the raptorial limbs, the tips of the thoracic appendages, and the uropods were bright crimson punctate with fine white dots. There were some dark markings on the telson and on the sides of the abdomen. The appendages of the first five abdominal somites were white. Soon after the specimen had been transferred to alcohol for better preservation, all the color faded away. One of our smaller specimens in alcohol has scattered stellate black pigment cells upon the dorsal surface from the eyes to the fifth abdominal somite, on the ventral side of the telson, and on the merus of the raptorial claw. On the carapace these are arranged in two transverse bands, one at each end; and on the exposed thoracic and abdominal somites there is a single broad transverse band on each tergite.

Distribution.— During the U. S. F. C. Hawaiian Explorations of 1902 the "Albatross" took in the tangles one specimen at each of the following stations: 4,159 and 4,161, both in the vicinity of Modu Manu, or Bird Islands, depth 30–31 fms. and 39–183 fms., bottom coral and sand; and station 3,845 on the south coast of Molokai, depth 60–64 fms., bottom sand and pebbles. All are females, total lengths 59.7 mm., *ca.* 24.3 mm., and 23.2 mm., respectively.

When I had the great privilege of examining the collection in 1910, there were five specimens in the British Museum (Natural History) the type, a female¹ from Fiji (White, 1861 and Miers, 1880); the "Challenger" specimen, a female from Honolulu (Brooks, 1886), and three females from Mauritius, the largest measuring 75 mm. from the tip of the rostrum to the end of the marginal teeth of the telson.

Since then, four other specimens have been recorded — a female 60 mm. in length in the Muséum National d'Histoire Naturelle (Paris)

¹ Brooks's reference to this as a male is evidently a slip of the pen; Miers describes it correctly as a female.

from Mauritius (Bouvier, 1915); a male (40 mm.) in the Bishop Museum dredged at Waikiki, Honolulu in 50 fms. (Edmondson, 1921); and two specimens in the Zoölogical Laboratory of the Paris Museum, a female 75 mm., from the coral reef on the south coast of Nouka Hiva Island in the Marquesas Archipelago, and a male, 32 mm., locality unknown (Gravier, 1928).

This species evidently has a wide geographical range, from Mauritius in the Indian Ocean on the west, to Hawaii and the Marquesas Islands on the east. Its habitat is among corals or on a sandy bottom at a depth ranging from a few feet (Carriè, Gravier) to at least 60 fathoms.

ODONTODACTYLUS Bigelow

Odontodactylus Bigelow, Proc. U. S. Nat. Mus., 1894, **17**, p. 445 (*ubi syn.*).

Odontodactylus Kemp, Mem. Indian Mus., 1913, **4**, p. 133.

Diagnosis.—Stomatopoda with a compact, generally convex and compressed hind body, without dorsal carinae on the first four abdominal somites. Carapace not greatly narrowed anteriorly, without carinae; gastric grooves distinct; cervical groove entirely absent. Ischio-meral articulation of raptorial claw situated at a point in advance of the proximal end of the merus; propodus not pectinate; dactylus inflated at the base and armed with two or more teeth on the inner margin. Shorter ramae of last three thoracic appendages linear and composed of two segments. Telson with sharp median carina and one or more carinae on either side; strong submedian, intermediate and lateral teeth on distal margin, the first with movable spines. Ventral process of uropods terminating in two sharp spines, of which the inner is usually the shorter.

Remarks.—The genus *Odontodactylus* is a compact group of ten known species, all found in the Indo-Pacific region except *O. havanensis* in the West Indies. They are much alike in most of their characteristics, and are closely related to Group I of the genus *Gonodactylus*, from which they differ chiefly in the structure of the raptorial claw.

Type Species.—*Odontodactylus scyllarus* (Linnaeus).

Species Represented in the Collection.—*O. japonicus*; *O. hansenii*.

ODONTODACTYLUS JAPONICUS (De Haan)¹

- Gonodactylus japonicus* De Haan, in Siebold's Fauna Japonica, Crust., atlas, 1844, (?) pl. 51, fig. 7.
- Gonodactylus edwardsii* Berthold, Abh. k. Ges. Wiss. Göttingen, 1845, **3**, p. 30, pl. 3, fig. 6.
- Odontodactylus japonicus* Bigelow, Proc. U. S. Nat. Mus., 1894, **17**, p. 496.
- Odontodactylus japonicus* Kemp, Mem. Indian Mus., 1913, **4**, p. 139, (*ubi syn*).
- Odontodactylus japonicus* Alexander, Jour. and Proc. Roy. Soc. W. Australia, 1916, **1**, p. 10.
- Odontodactylus japonicus* Komai, Annot. Zoöl. Japon., 1922, **10**, pp. 101-107, fig. 1-2.
- Odontodactylus japonicus* Parisi, Atti Soc. Ital. Sci. Nat, 1922, **61**, pp. 110-111, fig. 5.
- Odontodactylus japonicus* Komai, Mem. Col. Sci. Kyoto Imp. Univ. (B), 1927, **3**, pp. 336-338, pl. 13, fig. 3 and 4.

Diagnosis.—An *Odontodactylus* with subglobular eyes, the greatest diameter of the cornea being about one-fourth the length of the carapace, eye-stalks short; dorsal processes of the ophthalmic somite erect, wing-like, fused anteriorly at an angle, so that their crests are parallel to the sides of the rostrum; raptorial dactylus slightly dilated at the base and armed with five to seven teeth on its inner margin; mandibular palp composed of three segments; antennal scale large, nearly or quite as long as the carapace; rostrum subtriangular about one and a half times as broad as long, with its pointed apex strongly deflexed; carapace smooth with well marked gastric grooves, rounded angles, posterior margin concave, greatest breadth equal to length; fourth thoracic somite exposed, lateral margins of sixth and seventh rounded; first to fifth abdominal somites deep with vertical sides bordered by L-shaped marginal carinae, dorsally smooth, a distinct indentation on either side midway between lateral margin and median line of all but the first; sixth abdominal somite with four carinae and a large tubercle on either side, the lateral, outer intermediate, and submedian carinae ending in spines; median carinae obsolete; telson with median carina, not high, mucronate at posterior end, inner submedian carinae conspicuous, outer less prominent and continuous with one another around the posterior end of the median carina; intermediate carinae continued with a slight interruption to the apices of the submedian marginal teeth; first lateral carina obscure and sinuous in anterior half,

¹ For the sake of uniformity, I am following Stebbing (1908, p. 45) and Kemp (1913, footnote p. 66) in accepting the claim of De Haan (1849), that his plate with named figures was published before Berthold's (1845) paper.

posteriorly continuous with a distinct carina on each intermediate tooth, second lateral prominent and joined to the marginal carina at the apex of the lateral marginal teeth; submedian marginal teeth minutely serrate on inner margin, two denticles between submarginal and intermediate teeth, and one between intermediates and laterals; ventral process of uropod with two broad teeth, the outer about twice the length of the inner, and each with a strong flat ridge on its lower surface; proximal segment of uropod with eleven to thirteen very long, broad, and flattened movable spines, the distal one paddle-shaped and reaching almost to or beyond the end of the distal segment.

General Description.—Of this species Kemp (1913) has given an excellent description, from which the diagnosis above has been quoted, with some modifications. Our specimens differ from his in some minor features, and a few particulars may be added.

Our collection contains only one fully developed specimen, a male 115 mm. in length on the median line (Pl. 1, Fig. 1). In this one the eyes are unusually large in proportion to the length of the carapace, the maximum diameter being one-fourth the carapace length. (In the British Museum specimens the ratio is about 1:4.5). The very characteristic dorsal processes of the ophthalmic somite are fused at an angle like the mouth of a jug, and the rostrum fits neatly over the space behind like a lid. The carapace is a little longer than its greatest width at the posterior angles, and is much narrower anteriorly. The exposed thoracic and abdominal somites are robust. When viewed from above their sides form nearly a straight line. The postero-lateral angles of the fourth and fifth abdominal somites end in small spines. On the sixth abdominal somite the submedian, second intermediate, and lateral carinae have terminal spines. The tubercles on the anterior margin of the telson are inconspicuous. Of the uropods, the basal segment of the exopodite is close to twice the length of the distal segment, and the number of movable spines on the former is eleven. In this collection there is no mature female, but in the British Museum (Natural History) I had the privilege of comparing two males (139 and 164 mm.) with a large female (131 mm.) and found no secondary sexual differences.

Color.—The brilliant coloring of living specimens of this species has been described by Komai (1922; 1927, pl. 15, figs. 3-4). It is remarkable for its striking sexual dimorphism. In males, the whole dorsal surface of the body is bright salmon-red, shading into vivid purple on the antennal scales and uropods, while the marginal hairs of these appendages are very bright scarlet, and the mobile spines on the exopodites of the uropods are orange. In females, the posterior half

of the body is bluish green, shading into the salmon-red of the anterior half at the first abdominal somite.

Komai found one exceptional male with the female coloring, and upon dissecting it discovered that the testes were abnormal.

Distribution.— All the specimens in the collection were taken in the waters of Hawaii during April and July, 1902 — an immature female(?) 30.6 mm. in length, with *Gonodactylus guerinii* at station 3,845 on the south coast of Molokai in 60–64 fathoms, an immature male 33.5 mm. long at station 4,062 on the northeast coast of Hawaii Island, 83–113 fms., and one male 115 mm. long on the north coast of Maui in 95–152 fms.

The type locality for this species is Japan (De Haan), and it has been reported from that region by Balss, Kemp, Parisi, and by Komai, who says that it inhabits the warmer parts of the Japanese coast in the range of the "Black Stream," and is rather common. Other localities reported are — Chinese seas (Berthold, Miers), Hongkong (Kemp), Korea and the Bonin Islands (Komai), Saya de Malha Bank, southeast of the Seychelles (Borradaile), and Broome, Australia (Alexander). The specimens that I examined in the British Museum were from Swatow, China.

ODONTODACTYLUS HANSENI (Pocock)

Gonodactylus hanseii Pocock, Ann. Mag. Nat. Hist. (6), 1893, **11**, p. 477, pl. 20, fig. 3, 36.

Odontodactylus hanseii Bigelow, Proc. U. S. Nat. Mus., 1894, **17**, p. 496.

Odontodactylus latirostris Borradaile, Trans. Linn. Soc., Zool., (2), 1907, **12**, p. 212, pl. 22, figs. 3, 3a.

Odontodactylus hanseii Kemp, Mem. Indian Mus., 1913, **4**, p. 140.

Odontodactylus latirostris Kemp, *ibid.*, 1913, p. 141.

Odontodactylus hanseii Edmondson, Occ. Papers B. P. Bishop Mus., 1921, **7**, p. 297, fig. 1, *e* and *f*.

Odontodactylus hanseii Hansen, Siboga-Exped., Monogr., 1926, **35**, pp. 23–24, 44–46.

Diagnosis.— An *Odontodactylus* with large subglobular eyes, the diameter of the cornea varying from 2.5 to nearly 4 in the median length of the carapace; ophthalmic somite exposed, and the dorsal process deeply excavate anteriorly; antennal scale little shorter than the carapace, proportionally smaller in young individuals; mandibular palp of three segments; raptorial dactylus dilated at the base and armed with six to eleven marginal teeth, not including the terminal spine, which is slender with a marked reverse curve; rostrum broader

than long, evenly rounded or truncate triangular; carapace nearly as broad as long, angles rounded, anterior border transverse, posterior slightly concave; fourth thoracic tergite not exposed, margin of fifth not produced, of sixth and seventh rounded; first to fifth abdominal tergites of nearly uniform width, smooth except for a groove, deeper posteriorly, on the side of each somite, except the first, about one third the distance from the lateral margin to the median line; lateral

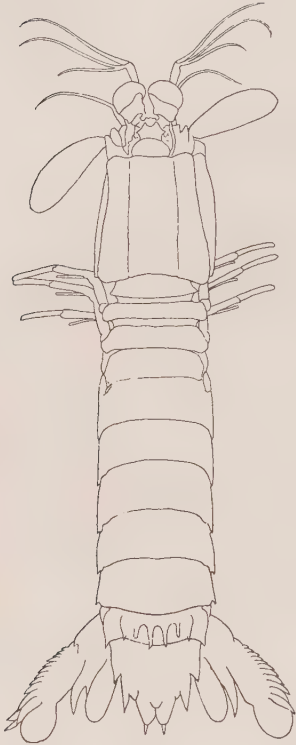


FIG. 2.—*Odontodactylus hansenii* (Pocock), male, 56.0 mm. (No. 24). The color pattern and details of the telson are not shown.

margins slightly thickened, ending in a spine on the fourth and fifth somites; sixth abdominal tergite with a pair of elongated tubercles and four pairs of carinae, three of them ending in spines, no median carina; telson wider than median length, median crest high and narrower with a short terminal spine and a distinct notch near the anterior end, a single pair of narrow submedian, intermediate, second lateral and marginal carinae (no first lateral carina), the second lateral carina running parallel to the margin except at the posterior end, where it may bend sharply toward the apex of the lateral tooth; three pairs of strong marginal teeth, the submedian pair finely serrate on inner margin and ending in a well developed mobile spine, two denticles between sub-median and intermediate teeth, and one between the intermediate and the lateral; on the dorsal surface of the uropods a deep longitudinal groove bordered by sharp ridges along the endopodite and the proximal segment of the exopodite; on the ventral surface of the basal process a sharp ridge extending to the tip of the inner spine, which is shorter than the outer one; movable spines on the exopodite ten to twelve,

acute, the distal one curved toward the apex of the broadly ovate distal segment, length variable.

General Description.—The collection contains seven specimens taken at six stations in Hawaiian waters during the explorations of 1902.

Comparison of these specimens with the type of *O. hansensii* Pocock in the British Museum and with the type of *O. latirostris* Borradaile at Cambridge enables me to confirm the supposition of Kemp (1913) and of Hansen (1926) that the two species are identical. The chief difference between the two types is in the number of teeth on the raptorial dactylus, nine in addition to the terminal spine in *O. hansensii* and seven in both specimens of *O. latirostris*; but these numbers are within the range of variation shown by the present collection. There is also a slight difference in the rostrum — evenly rounded in the type, truncate triangular in *O. latirostris*.

Kemp (1911, 1913) has described as *Odontodactylus southwelli* a very similar form "that may be distinguished from them at a glance by the enormous size of the eyes." It is undoubtedly this form that was taken by the "Siboga" Expedition, but Hansen (1926) supposes this to be identical with *O. hansensii*. Hansen is perfectly correct in saying that full size of the eyes is not seen in dorsal view. In preserved specimens the longest diameter of the cornea is nearly vertical, but in all the specimens that I have measured, including the type of *O. latirostris*, there is none in which this diameter is contained less than 2.5 times in the median length of the carapace. Kemp gives the size as 2.25 in the carapace, the proportion remaining approximately constant in five specimens between 21 and 37 mm. in total length, while Hansen gives the proportion in the five "Siboga" specimens as ranging from 1:2 to 1:2.66, the total length being from 16 to 62 mm. In six specimens of our collection, 28.5 to 80.6 mm. long, the proportion of maximal corneal diameter to carapace varies from 1:2.5 to 1:3.9, and the types of Pocock and of Borradaile fall within this range. Unfortunately, while verifying Pocock's description by comparison with the type, I did not repeat his measurements; but I have no doubt that they are correct. Hansen says that in the "Siboga" specimens the eyes are proportionally smallest in the largest specimen and largest in the smallest specimen. My results when arranged in order of size are too irregular to permit of any generalization. Kemp records a male of *O. southwelli* ca. 28 mm. long. The two smallest specimens in our collection are of about the same size. I am unable to determine their sex, but they may be females.

A peculiar feature of our largest specimen is a distinct spinule on the dorsal surface of the ophthalmic somite, just behind each dorsal process. Another specimen shows traces of these spinules.

Another specimen (26♂) has the surface of the telson distinctly pitted on both sides of the intermediate carinae, with somewhat less distinct pits on the ventral surface.

O. hansenii may be distinguished at a glance from *O. japonicus* by differences in the sculpturing of the telson. In the former there is on each side a single submedian carina, the intermediate is not continuous with the dorsal crest of the submedian tooth, the first lateral is represented only by the dorsal crest of the intermediate tooth, and the second lateral does not run a straight course toward the tip of the lateral tooth but is mainly parallel to the lateral margin.

Our series furnishes an interesting comparison of the proportions of the parts at various stages of development, from juvenal specimens of indeterminate sex about 28 mm. long to a fully developed female 80 mm. long. In the large specimen the raptorial dactylus is strongly dilated toward the base, while in all the smaller ones it is moderately dilated, as described by Kemp. In the large specimen the posterior end of the lateral carina of the telson follows the inner margin of the lateral tooth to its tip, and unites there with the marginal carina, as figured by Edmondson (1921, fig. 1f). In younger individuals it terminates before reaching the tip of the tooth, as described by Kemp. The last movable spine of the uropod in the large specimen is three-quarters the length of the terminal segment; in the juvenals it reaches the tip of the segment, and is intermediate in length in the others. Likewise, the outer spine of the basal process in the largest female does not reach to the end of the endopodite, while in all the others it extends that far or farther. Our youngest specimens show some of the characteristics of Hansen's later postlarval stage (Hansen, 1926, pp. 44-46).

Color.—The only information that we have of the color of living specimens is a note on the label of the two males from station 3,845, "Last segment of telson pink, eyes apple green, dorsum rusty, mottled." In alcohol these and several other specimens have the eyes brown, streaked horizontally with black, and on the proximal segment of the exopodite is a dense black patch, on both dorsal and ventral sides and extending on to the corresponding part of the basal process. This marking is very characteristic of the species, but in the large female and a smaller male the black pigment is chiefly on the basal segment, extending partly over the proximal segment of the exopodite.

Distribution.—The stations and depths at which this species was taken by the "Albatross" are:—3,845, south coast of Molokai, 60-64 fms.; 3,861, Pailolo Channel between Molokai and Maui, 30-52 fms.; 3,982, off Kauai, 233-240 fms.; 4,031 and 4,034, Penguin Bank, south coast of Oahu, 27-28 and 24-83 fms.; 4,061, northeast coast of Hawaii Island, 24-83 fms. Edmondson (1921) reports three specimens in the Bishop Museum from off Waikiki, Honolulu, 30-50 fms.; and Hansen (1926) reports a specimen in the Copenhagen Museum from Hawaii.

The type (Pocock, 1893) is from Macclesfield Bank, South China Seas, 35 fms.; and Borradaile's specimens are from the Amirante Islands, 25-30 fms. Other localities recorded are Yoko (=Sulu) and Amboina Bay (Hansen). The "Siboga" specimens were taken at North Ubian in the Sulu Sea, at two stations off the northwest of New Guinea and at Benda (south of the Moluccas). Kemp's specimens of *O. southwelli* are from several localities in the Andaman Islands and from N. Cheval Parr, Ceylon. The distribution so far recorded includes the Hawaiian Islands, the East Indian Archipelago, and the Indian Ocean.

List of Specimens

No.	Sex	Length	Station
23	♀	80.6 mm.	4031
24	♂	56.0	3982
25a	♂	52.0	3845
25b	♂	40.9	3845
26	♂	33.0	4061
27	juv.	28.5	4034
28	juv.	27.4	3861

PSEUDOSQUILLA Dana

Squilla, squilles trapues H. Milne-Edwards, Hist. Nat. Crust., 1837, **2**, pp. 518, 525.

Gonodactylus H. Milne-Edwards, *ibid.*, 1837, pp. 528, 530 (*partim*).

Squilla sect. *parallelae* De Haan, in Siebold's Fauna Japonica, Crust., 1849, p. 221.

Pseudosquilla (Guerin *ined.*) Dana, U. S. Explor. Exped., Crust., 1852, p. 621.

Pseudosquilla Miers, Ann. Mag. Nat. Hist. (5), 1880, **5**, p. 108.

Pseudosquilla Brooks, Voy. H. M. S. "Challenger," 1886, **16**, p. 53.

Pseudosquilla Bigelow, Proc. U. S. Nat. Mus., 1894, **17**, p. 498.

Pseudosquilla Kemp, Mem. Indian Mus., 1913, **4**, p. 94.

Diagnosis.—Stomatopoda with hind body generally very convex and smooth, without sharp carinae, except on the last two somites; mandibular palp composed of three segments; dactylus of raptorial claw not inflated and armed with teeth, of which there are not more than four including the terminal one; upper margin of propodus finely pectinate externally, merus articulating terminally with the ischium, and its ventral surface channeled throughout its length; shorter ramus of the last three thoracic limbs linear; telson with a median crest and

one to five pairs of additional carinae; submedian, intermediate, and lateral marginal teeth well formed, the first with movable tips; no submedian denticles and never more than three intermediate ones.

Remarks.—The diagnosis, quoted in part from Kemp (1913), is intended to exclude *P. stylifera* (H. Milne-Edwards), for which Hansen suggested without description (1895) a new genus, *Hemisquilla*. This has been accepted by Kemp and Chopra (1921) because of the outstanding peculiarities of the species in question. Kemp states that the species of *Pseudosquilla* are invariably found in shallow water, and seem to prefer rough ground, coral reefs, oyster beds, and similar situations. They are distributed throughout the warmer waters of both hemispheres.

Type Species.—*Pseudosquilla lessonii* (Guerin).

Species Represented in the Collection.—*P. ciliata* (Fabricius); *P. ornata* Miers; *P. oculata* (Brullé).

PSEUDOSQUILLA CILIATA (Fabricius)

Squilla ciliata Fabricius, Mantiss. Insect., 1787, **1**, p. 333.

Cancer ciliatus Linnaeus, Syst. Nat., ed. 13, 1790, **1**, p. 2990.

Squilla ciliata Fabricius, Ent. Syst., 1793, **2**, p. 512.

Squilla stylifera Lamarck, Hist. Nat. Anim. Sans Vert., 1818, **5**, p. 189.

Squilla quadrispinosa Eydoux and Souleyet, Voy. de la "Bonite," Zoöl., 1841, **1**, Crust., p. 262, pl. 5, fig. 1.

Pseudosquilla stylifera Dana, U. S. Expl. Exped., Crust., 1852, **1**, p. 622, pl. 41, figs. 4a-e.

Pseudosquilla ciliata Miers, Ann. Mag. Nat. Hist., (5), 1880, **5**, pp. 108, 458, pl. 3, figs. 7, 8.

Pseudosquilla ciliata Brooks, Voy. H. M. S. "Challenger," 1886, **16**, Stomatop., p. 53, pl. 15, fig. 10.

Pseudosquilla ciliata Bigelow, Proc. U. S. Nat. Mus., 1894, **17**, p. 499.

Pseudosquilla ciliata Bigelow, Bull. U. S. Fish Comm., 1902, **20**, pt. 2, p. 154, figs. 3, 4.

Pseudosquilla ciliata Balss, Abh. Math.-Phys. Kl. K. Bayer. Akad. Wiss., 1910, Suppl., Bd. 2, Abh. 2, p. 6.

Pseudosquilla ciliata Balss, Denk. Math. Nat. Kl. K. Akad. Wiss. Wien., 1910 (1912), preprint of **87**, Fortsetzung B., p. 32.

Pseudosquilla ciliata Kemp, Mem. Indian Mus., 1913, **4**, pp. 96-100, 108, 196. (Includes complete bibliography to 1910.)

Pseudosquilla ciliata Bouvier, Bull. Sci. France et Belg., 1915, **48**, p. 311.

Pseudosquilla ciliata Kemp, Philip. Jour. Sci. (D), 1915, **10**, p. 172.

Pseudosquilla ciliata Sunier, Inst. Sci. Buitenzorg, Contr. Faune Indes Néerl., 1918, **1**, (4), p. 72.

- Pseudosquilla ciliata* Rathbun, Netherlands Kolonien Min. Rapp. Betref. Visscherij Curaçao, 1919, **2**, p. 347.
- Pseudosquilla ciliata* Tattersall, Jour. Linn. Soc. Zoöl., 1921, **34**, p. 357.
- Pseudosquilla ciliata* Edmondson, Occ. Papers B. P. Bishop Mus., 1921, **7**, pp. 288-290.
- Pseudosquilla ciliata* Parisi, Atti Soc. Ital. Nat., 1922, **61**, p. 103.
- Pseudosquilla ciliata* Odhner, Göteborgs Vet. Handl. (4), 1923, **27**, (4), p. 6.
- Pseudosquilla ciliata* var. *occidentalis* Verrill, Trans. Conn. Acad. Arts and Sci., 1923, **26**, pp. 192-193, pl. 50, fig. 1, 2; pl. 51, fig. 1, 1b; pl. 54, fig. 2.
- Pseudosquilla ciliata* Schmitt, Bijdr. Dierk., Amsterdam, 1924, **23**, p. 81.
- Pseudosquilla ciliata* Edmondson, B. P. Bishop Mus. Bul., 1925, No. 27, p. 59.
- Pseudosquilla ciliata* Hansen, Siboga-Exped. Monogr., 1926, **35**, (Livr. 104), pp. 17-18.
- Pseudosquilla ciliata* Komai, Mem. Col. Sci., Kyoto Imp. Univ., (B), 1927, **3**, pp. 323-324.

Diagnosis.—A *Pseudosquilla* with cylindrical eyes; the dactylus of the raptorial claw slender, with three elongated teeth, including the terminal one, and the propodus bearing three movable spines at the base of its pectinate margin; rostrum wider than long, widest in front of the base; lateral margins strongly rounded and meeting apically in a very obtuse angle; carapace considerably longer than wide, without carinae or cervical groove, gastric grooves converging anteriorly, and antero-lateral angles rounded; four thoracic somites exposed, smoothly arched dorsally, the fifth with a deep vertical groove on its lateral face, lateral margins slightly produced, the fifth acute, the others more or less rounded, the eighth with a small and deeply incised apical notch; the first five abdominal somites strongly arched and smooth, except for a Y-shaped groove on the lateral face of the first and a pair of pits on each of the four succeeding somites; postero-lateral angles of the first three rounded, of the fourth rounded or ending in a small spine, of the fifth invariably spinous; sixth abdominal somite with six strong spines, the intermediate pair arising farther forward than the others, about halfway between the anterior and posterior margins; the telson with a high narrow crest ending in a spine, and six other carinae, one pair on the lateral margins and two pairs grouped near the crest, the submedian pair being low; six large marginal spines, the submedian pair long and mobile; the basal process of the uropods long and ending in two slender spines, of which the inner one is the longer and reaches nearly to the apex of the exopod, seven to ten movable spines on the proximal segment of the exopod, the terminal one not extending beyond the apex of the ultimate segment, which is at least one-half the length of the proximal one, a single fixed spine on the ventral surface at the articulation between the two segments.

In the "Challenger" collection there were two specimens from the West Indies and one from Honolulu. Brooks (1886) found that the

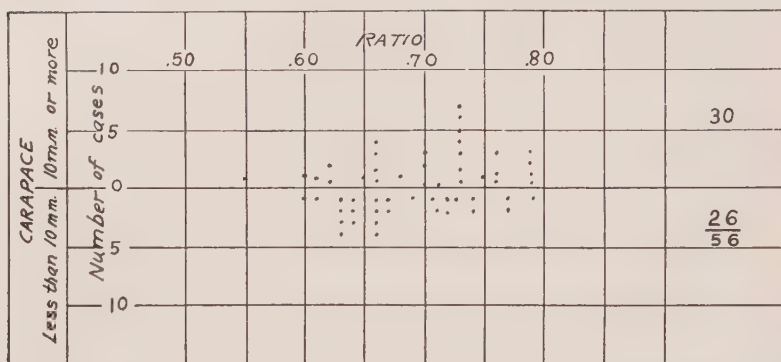


FIG. 3.—Ratio of length of distal segment of exopodite of uropod to that of proximal segment in 56 specimens of *P. ciliata*, 30 larger specimens (carapace length 10 mm. or more) compared above the zero line with 26 smaller ones below that line.

West Indian specimens differed from the one from Honolulu in three points: (1) the paddle of the uropod was a little shorter than the proximal segment of the exopodite, (2) the spines of the basal process of the uropod were equal in length, and (3) the postero-lateral angles of the fourth abdominal somite were produced into small but distinct spines. Borradaile (1900) proposed on these characters to separate the Atlantic from the Pacific form as var. *occidentalis*. But Tattersall (1906) had a specimen (33 mm.) from Ceylon which he compared with Brooks's specimens in the British Museum and found that "this specimen agrees with Brooks's West Indian examples in those points in which the latter differ from the Pacific ones."

Measurements of fifty-six specimens having a total length of 30 mm. or over in our collection show a wide range of variation in the ratio of the lengths of the two segments of the exopodite of the uropod. The

distal segment is always the shorter and varies from 0.55 to 0.79 of the length of the other. The ratios, when plotted (Fig. 3), show a tendency for the ratio to increase with the size.

In our collection the inner spine of the basal prolongation of the uropod is invariably longer than the outer one, and this has been found to be true also of West Indian specimens by Bigelow (1902) and by Verrill (1923).

The postero-lateral angles of the fourth abdominal somite in one of our Samoa specimens are distinctly produced as spines. In the other two they are not clearly spinous, but are more or less acute. The

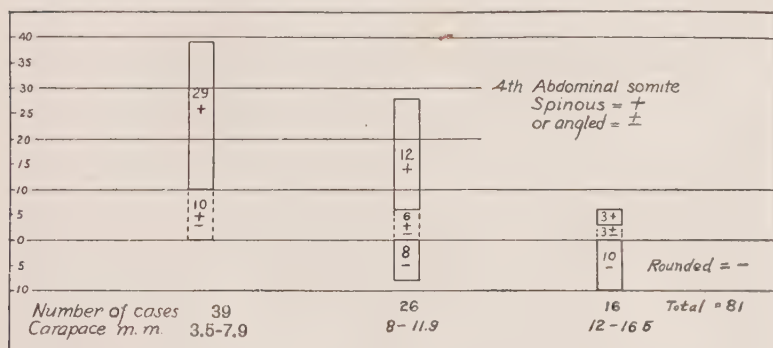


FIG. 4.— Diagram of 81 specimens of *P. ciliata* (3 from Samoa and 79 from the Hawaiian Islands) showing the number having the fourth abdominal somite spinous (+), angled (±), or rounded (-) at the postero-lateral angle; in three size-groups, small, medium, and large, — carapace lengths 3.5 to 7.9, 8 to 11.9, and 12 to 16.5 mm., respectively.

seventy-eight specimens from Hawaii vary from strongly spinous to decidedly rounded angles. These variations, when plotted against length of carapace (which, as pointed out by Kemp, can be measured more accurately than total length), clearly show (Fig. 4) a tendency for the spines to disappear with increase in the size of the animal.

The smallest specimen in the collection that has the characteristics of the adult form is a male 17.5 mm. long. It differs from the fully developed adult only in the absence of submedian carinae on the telson and in the incomplete development of the intromittant organs, which are 0.42 mm. long and reach only halfway from the base of the exopodite to the median line. The specimen shows traces of the characteristic pigmentation of the species.

In the report on the Porto Rico collection of the U. S. Fish Com-

mission (Bigelow, 1902, p. 156), mention is made of five similar specimens ranging in size from 16 mm. to 17.5 mm., and Kemp (1913, pp. 100 and 108) records two specimens in the Indian Museum, as small as 19 and 27 mm. in length, that possess all the adult characteristics.

These specimens, at the beginning of the adult stage, are of special interest because of the aid they furnish in the identification of the previous postlarval stage. As pointed out by Kemp (1913, p. 108), their existence does not necessarily prove that the *monodactyla* stage of the same size does not belong to this species. In fact, comparison of the two stages in the Porto Rico collection led to the opinion that, at the time of metamorphosis, growth results in a thickening of the body without an increase, or with a slight shrinkage in length; and Kemp has suggested independently the same thing.

Postlarval stage.—The larval stage of *P. ciliata* has been identified by Hansen (1895) and named *Pseuderichthus communis*. He distinguished it from the very similar larva of *P. oculata* Brullé by its smaller size and the possession of eight distinct spines on the uropod. This stage has been more fully described and figured by Jurich (1904, pp. 395–96, pl. 29, fig. 1). Among other distinctive characters, he mentions the slightly concave posterior margin of the telson, without median indentation, and bearing tertiary spinules.

Between the *pseuderichthus* stage and the first adult stage there is a transitional stage, first described by Claus (1871, figs. 26 and 27c). Hansen has found by comparison of the type specimens that the form described by A. Milne-Edwards (1878) as *Squilla monodactyla*, and by Miers (1880) as *Pseudosquilla monodactyla* is this stage in the life-cycle of *Pseudosquilla oculata* Brullé, and Hansen mentions two specimens in the Copenhagen Museum that are this stage of *P. ciliata*, having a length of 17.5 and 21.3 mm. The Porto Rico collection contained five specimens of *P. ciliata* in the *monodactyla* stage. These were briefly described (Bigelow, 1902, p. 156).

The present collection contains three specimens in this stage, all from the Hawaiian Islands, as follows: station 3,812, south coast of Oahu, March 27, 1902, 7.30 P.M., surface, 20.4 mm.; station 3,847 south, coast of Molokai, April 8, 1902, noon, 1♂ 18.0 mm.; station 3,921, off Honolulu, south coast of Oahu, May 6, 1902, 8.45 P.M., 17.5 mm.

Two of the specimens are in excellent condition and furnish material for a more detailed description of this interesting stage. They differ from the adult form chiefly in the more slender proportions of the body, in the shape of the eyes and of the raptorial dactylus, and in the presence of thirty-five to thirty-six minute denticles on the pos-

terior margin of the telson between the mobile submedian teeth (Fig. 5). These denticles, secondary spinules of Jurich, are of nearly uniform size. There is no indication of the tertiary spinules that Jurich finds to be characteristic of the *pseuderichthus* stage of this species. The dactylus of the raptorial limbs is without lateral teeth, but beneath the integument the rudiments of the two lateral teeth are more or less clearly visible. The propodus bears the usual three movable spines, and has a strong spine near the distal articulation (Fig. 6). In place of the usual pectinations on the upper edge, there is a

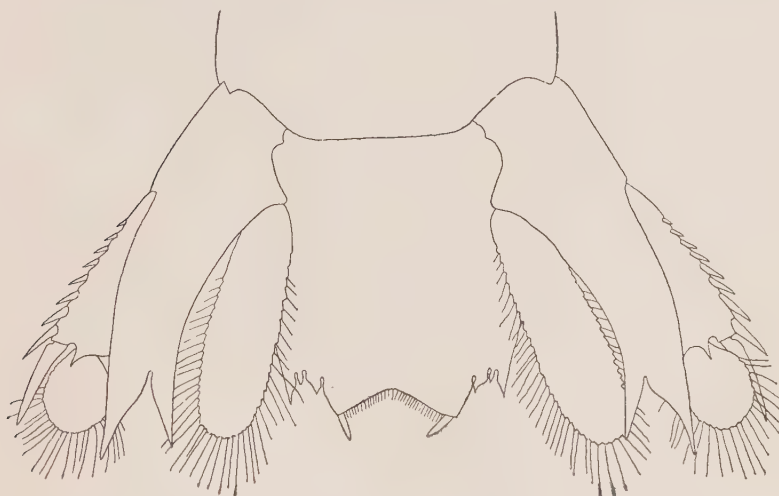


FIG. 5.—Telson and uropods of *P. ciliata* in the postlarval stage, ventral aspect.

series of fine hairs. The eyes are large and, unlike the adult form, are somewhat compressed laterally. They differ in shape from the eyes, at this stage, of both *P. ornata* and *P. oculata* in being elliptical in lateral view. The keel on the dorsal process of the basal segment of the antennae is *concave* in lateral view, as in the adult.

The rostrum is of the adult form, wider than long, the apex obtuse and depressed. The carapace is of the adult form but not so broad, its width being less than half its length. The postero-lateral angles of both the fourth and the fifth abdominal somites are strongly spinous. The sixth abdominal somite has the usual submedian and lateral marginal spines, but no trace of the intermediate pair. The telson is wider than long, smooth above, except for a low narrow median crest that ends

in a sharp spine at a *considerable distance* (0.16 to 0.23 mm.) from the posterior margin, which forms an obtuse reëntrant angle. The marginal teeth and denticles, except the submedian ones mentioned above, are of the adult form. The two spines of the basal process of the uropods are of nearly equal length, the *outer spines being slightly the longer*. The paddle of the exopod is about *half* the length of the proximal



FIG. 6.— Raptorial limb of *P. ciliata* in the postlarval stage.

segment, which in all three specimens bears *nine* movable spines. Both the basal process and the distal spine of the exopod are relatively longer than in the adult form.

The records of capture of specimens in the *monodactyla* stage indicate that at this period in the life-cycle, the animals inhabit the bottom during the day and swim near the surface at night.

Color.— George Clark (1869, *sub Squilla styliifera*) has observed that, "When first hatched the larvae are of a delicate yellowish green.

As they grow they assume a mottled grey, and the swimmerets and legs become pea-green." Preservation in alcohol destroys all traces of color, excepting the retinal pigment, in specimens of the *pseuderichthus* and *monodactyla* stages. The earliest adult stages show, however, traces of what appears to be a characteristic color pattern. This consists of groupings of black pigment cells that form a series of dark patches on each side of the body. There are three pairs of these patches on the carapace, and one pair on each of the other segments, including the telson. The extent to which this pattern is represented varies greatly in different individuals, the patches most frequently observed being those on the sixth thoracic and first abdominal somites (Edmondson, 1921) and on the telson. There may be only a single pair of patches, or none at all.

The color of living adults has been described by Clark (1869) and by Verrill (1923). It is interesting to note that in this species, which shows no structural sexual dimorphism, both Clark at Mauritius and Verrill at Bermuda observed sexual differences in color, the male being often bluish green with red markings on the appendages, while the female is often mottled with brown and gray, but also trimmed with red. In our collection I have noticed a black spot on the ventral surface of the sixth thoracic somite just behind the genital pores of all except the smallest females, and the entire absence of this spot in all males.

Distribution.— Among all known species of Stomatopoda there are only three or four that have been found both in the Atlantic and the Indo-Pacific region. *Pseudosquilla ciliata* is one of the most common of these, occurring in abundance in shallow water among corals and in similar situations, over a wide range (see Kemp, 1913, p. 100).

Our three specimens from Samoa are all from shore collections, and the same is true of a large proportion of the Hawaiian specimens. The greatest depths from which specimens were taken are at station 3,850, 43–66 fathoms, and station 4,055, 50–62 fathoms. One specimen was obtained from the Honolulu market, indicating that this species is an article of food.

Size.— Our specimens in the adult stage range in size from 17.5 to 75.5 mm. Kemp (1913) records a female from Samoa that is 81 mm. in length.

Table of Measurements
P. ciliata, postlarval form

Specimen no.	35r	58a	64
Sex	♂	♀ ?	?
Total length	18.0 mm.	20.4 mm.	17.5 mm.
Carapace length	3.67	3.84	4.17
Rostrum length	0.92	1.02	—
width	1.40	1.48	—
Eye width	1.00	1.04	—
length	1.80	1.83	—
height	1.20	1.33	—
Telson length	2.58	2.66	—
width	2.67	2.75	—
Tip of median spine to			
edge of telson	0.16	0.16	0.23
Uropod, exopodite distal seg.	0.80	0.88	0.72
prox. seg.	1.52	1.60	1.52
number of mobile spines	9	9	9

PSEUDOSQUILLA ORNATA Miers

Pseudosquilla oculata Heller, Verh. Zool.-Bot. Ges. Wien, 1861, **11**, p. 497 (*nec* Brullé, 1836-44).

Pseudosquilla ornata Miers, Ann. Mag. Nat. Hist. (5), 1880, **5**, p. 111, pl. 3, figs. 5. 6.

Pseudosquilla ornata, Kemp, Mem. Indian Mus., 1913, **4**, pp. 100-101.

Pseudosquilla ornata Bouvier, Bull. Sci. France et Belg., 1915, **48**, p. 311.

Pseudosquilla ornata Kemp, Philip. Jour. Sci. (D), 1915, **10**, p. 172.

Pseudosquilla ornata Parisi, Atti Soc. Ital. Sci. Nat., 1922, **61**, p. 103.

Pseudosquilla ornata Komai, Mem. College of Sci. Kyoto Imp. Univ. (B), 1927, **3**, pp. 324-325, pl. 14, figs. 2-2b.

Diagnosis.—A *Pseudosquilla* having a narrow, strongly arched body, the greatest breadth of the abdomen about one-sixth the total length; eyes club-shaped, the cornea dorso-ventrally flattened and set transversely on the stalk; dorsal process of the basal segment of the antenna is deeply channeled dorsally, and the margin of its ventral keel is convex in lateral view; mandibular palp of three segments; dactylus of raptorial claw with two lateral teeth in addition to the terminal one, the edge of the propodus pectinate along about half its length and armed with three movable spines, a small depressed spine at the distal end of the segment, distal margin of the carpus produced ventrally into

a short spine; rostrum nearly twice as broad as long; seventh thoracic somite squarely truncate laterally, and the eighth obscurely incised; telson with a narrow median crest ending in a spine, and three pairs of carinae — submedian, intermediate, and lateral; the marginal teeth strongly developed, the intermediate pair reaching to the level of the bases of the movable spines of the submedian ones, and the denticles lobular in form; outer spine of the basal process of the uropods much longer than the inner spine, and reaching to the distal end of the exopod; on the proximal segment of the exopod nine to eleven movable spines, the distal one exceeding the length of the ultimate segment, which is less than half the length of the proximal segment.

General Description.— Of this species the collection contains a single adult specimen, a female 69 mm. in length, in excellent condition, from the coral reef at Apia in Samoa.

The body is slender and compact, with nearly straight sides, the greatest width of the carapace and of the abdomen being little more than one-seventh of the total length. The depth of the abdomen is about eight-tenths of its breadth. The eyes are somewhat club shaped, the corneal area being somewhat wider than the stalk, and the eyes are slightly flattened obliquely. The raptorial limb closely resembles that of *P. ciliata*, except in one feature. That is a distinct spine on the ventral (not "dorsal") edge of the carpus. In this it appears to differ from the specimens in the Indian Museum (Kemp, 1913, p. 101) and to agree with the specimens described by Komai (1927) and with Borradaile's *P. oxyrhyncha* (1898, pl. 6, fig. 9). Komai (1927) regards *P. oxyrhyncha* as a synonym of *P. ornata* because of this feature and because of variation that he found in the form of the rostrum, one of his two specimens having the apical spine characteristic of *P. oxyrhyncha* and the other being without it. In our specimen the apex of the rostrum is a very obtuse angle without trace of spine. Its sides are broadly rounded.

The carapace is very smooth, but with distinct gastric grooves. The angles are rounded, the anterior border nearly transverse, and the posterior margin evenly concave. The postero-lateral angles of the first to third abdominal somites are rounded, of the fourth rectangular, and of the fifth spinous. The sixth abdominal somite and the telson are like those of *P. ciliata*, except that the spines are a little stronger. The intermediate marginal teeth of the telson are, however, not so long as figured by Miers (1880, pl. 3, fig. 6). They extend only a little beyond the articulation of the movable submedian teeth, not to the tips. There is a deep fissure between the intermediate denticles, and the

ventral surface of the telson is considerably more concave than in *P. ciliata*. The uropods present several differences from *P. ciliata*. The endopod is narrowed posteriorly. The distal segment of the exopod is little more than one-third the length of the proximal segment, which bears a strong fixed spine at its distal end on the ventral side, and on the outer edge ten movable spines, the outermost one extending well beyond the apex of the distal segment. The inner spine of the basal process reaches the base of the distal segment, and the outer one terminates just at its tip. The inner margin of the basal process is smooth, except that there is a small blunt tooth near the base of the inner spine.

Color.—The only information available as to the color of this species in life is from the label with an immature specimen from the Philippines quoted by Kemp (1915, p. 172) as follows: "Red with brown tinge and with cream colored dots and cream colored bars transversely on carapace and on telson, extending on to the uropods." The specimen in alcohol shows also traces of eye-spots on the carapace. A pair of large eye-spots on the carapace appears to be the most striking characteristic of this species (Komai, 1927, pl. 14, fig. 2). On our specimen each of these spots consists of a central bluish black area circular in outline and about 3.5 mm. in diameter, surrounded by a narrow pale border. The gastric groove traverses the upper half of the spot. The ground color of our specimen in alcohol is a brownish purple. In front of the eye-spots the carapace is marked by a median and two lateral pale areas beset with numerous small round spots of the ground color with lighter centers. There are dark shadings on the sides of the abdominal somites, and the telson and uropods are dark with transverse pale bars. The walking legs and the propodus of the raptorial claw are orange, and the dactylus pink. The ventral surface of the thorax is marked by a dark patch near the base of each walking leg, as described by Komai.

Postlarval Stage.—In a container with a specimen of *Gonodactylus glabrous* from Apia was found a *Pseudosquilla* in the *monodactyla* stage. This appears to represent the postlarval form of *P. ornata*, not before described, so far as I know. The animal is a male, 20.5 mm. long on the median line. It is remarkable for the precocious development of the intromittent organs. Although the rudiments of the lateral teeth on the dactylus are hardly visible beneath the integument, the intromittent organs are as far advanced as in the first adult stage of *P. ciliata*, reaching halfway to the median line, whereas they are mere buds in the same stage of *P. ciliata*.

In addition to this peculiarity, the specimen may be distinguished from the *monodactyla* stage of *P. ciliata* at a glance by the shape of the

eyes and of the rostrum and the structure of the uropods. The eyes are *pyriform*, slightly flattened on their medial sides. The rostrum, a little wider than long, is *subtriangular*, with nearly straight sides, and the tip slightly depressed, but *not* furrowed. The width of the telson is *less*



FIG. 7.—Raptorial limb of *P. ornata* in the postlarval stage.

than its median length. The telson is smooth above except for a low median crest that ends in a sharp spine a *considerable distance* (0.25 mm.) from the posterior margin, as in *P. ciliata*, and the lateral margin is slightly raised, forming a carina. The posterior margin is like that in *P. ciliata*, and bears about thirty-two minute spinules. The intermediate and lateral denticles on the inner sides of the corresponding marginal teeth are well developed and acute. The uropods are like those of *P. oculata* (see below). The outer spine of the basal process is *much longer* than the inner one, and its inner border is markedly sinu-

ous. The paddle of the exopod is about *one-third* (0.35 mm.) the length of the proximal segment, which on one limb bears nine movable spines and ten on the other. *Ten* seems to be the normal number.

The dorsal process on the basal segment of the antennae is more erect than in *P. ciliata* and its ventral margin is somewhat *convex* as in the adult. The distal spine on the propodus of the raptorial limb is not so prominent as in *P. ciliata* and *P. oculata*, not extending beyond the articulation (Fig. 7), and the ventral margin of the carpus projects strongly, suggesting the spine characteristic of the adult. The posterior border of the carapace is evenly concave, and bears a minute tubercle on the median line. The postero-lateral angles of the first to third abdominal somites are rounded, of fourth and fifth spinous, and the sixth abdominal somite bears the submedian and lateral spines characteristic of this stage.

Measurements of this specimen are given in the table below with those of the adult.

Distribution.—The two specimens in the present collection are both from Apia, Samoa. The species has been reported from Samoa by Ortmann and by Parisi. It was first taken at Tahiti, and occurs as far west as Mauritius and north to Japan, but has not been recorded from the Hawaiian Islands.

Table of Measurements

Station: Apia, July, 1902.	Specimen No.	46	19b
	Sex.....	♀	♂ juv.
		mm.	mm.
Total length, median line.....		69.0	20.5
Carapace, length.....		15.0	3.92
Carapace, breadth.....		10.5	2.83
Rostrum, length.....		2.5	1.20
Rostrum, breadth.....		4.4	1.40
Fifth abdominal somite, breadth.....		10.5	—
Fifth abdominal somite, dorsum to ventral spine...		8.0	—
Telson, median length.....		7.0	2.83
Telson, length to tip of submedian spine.....		10.6	—
Telson, length to base of mobile spine.....		—	3.17
Telson, breadth.....		8.5	2.67
Telson, depth at anus.....		3.5	—
Eye, vertical diameter.....		—	1.32
Eye, longitudinal diameter.....		—	1.88
Antennal scale.....		7.7	1.80
Uropod, length proximal segment of exopodite....		7.0	1.92
Uropod, length distal segment of exopodite.....		2.5	0.68

PSEUDOSQUILLA OCLATA (Brullé)

- Squilla oculata* Brullé in Webb and Berthelot's Iles Canaries, Zoöl., 1836-44, 2, Crust., p. 18, fig. 3.
- Squilla monodactyla* A. Milne-Edwards, Bull. Soc. Philom., Paris, 1878, (7), 2, p. 232.
- Pseudosquilla oculata* Miers, Ann. Mag. Nat. Hist., (5), 1880, 5, p. 110, pl. 3, figs. 3, 4.
- Pseudosquilla monodactyla* Miers, *ibid.*, 1880, pp. 110-111, pl. 3, figs. 1, 2.
- Pseuderichthus distinguendus* Hansen, Isop. Cumac. u. Stomatop. Plankton Exped., 1895, p. 86.
- Pseuderichthus distinguendus* Jurich, Stomatop. Deutsch. Tiefsee-Exped., 1904, pp. 394-395, pl. 27, fig. 5.
- Pseudosquilla oculata* Kemp, Mem. Indian Mus., 1913, 4, pp. 102-103, 108.
- Pseudosquilla oculata* Pesta, Denk. K. Akad. Wiss. Wien., 1914, 89, p. 682.
- Pseudosquilla oculata* Bouvier, Bull. Sci. France et Belg., 1915, 48, p. 311.
- Pseudosquilla oculata* Edmondson, Occ. Papers Bishop Mus., 1921, 7, pp. 290-292.
- Pseudosquilla oculata* Odhner, Göteborgs Vet. Handl., (4), 1923, 27, p. 6.
- Pseudosquilla oculata* Edmondson, Bull. Bishop Mus., 1925, No. 27, p. 59.

Postlarval Stage.—Not a single adult specimen of *Pseudosquilla oculata* is to be found in the present collection, although the species has been reported from Samoa by de Man (1891) and by Pesta (1914), and Edmondson reports (1921) eleven specimens in the Bishop Museum from Oahu and (1925) sixty-eight specimens collected by the "Tanager" expedition among the leeward Hawaiian Islands to the northwest of the main group.

While apparently less abundant, this species seems to be as widely distributed as *P. ciliata*, having been found at the Cape Verde Islands and at Madeira in the eastern Atlantic, as well as in the Indo-Pacific region from Samoa, the Society Islands, and Hawaii to Mauritius. Odhner (1923) has extended the known distribution to the Gilbert and the Bonin Islands.

The adult form is distinguished from both *P. ciliata* and *P. ornata* by the presence of an apical spine on the rostrum and an additional longitudinal carina on the telson. It resembles *P. ornata* in having the outer spine of the basal process of the uropod longer than the inner one, and in the presence usually of ten to eleven movable spines on the exopod (Hansen, 1895, p. 86). The eyes are also flattened as in *P. ornata*, but are shorter and more thick-set; and the ultimate segment of the uropod is even smaller than in *P. ornata*, being much less than half the length of the proximal segment of the exopod (Kemp, 1913,

p. 102). The largest adult recorded by Edmondson (1921) is a female 55 mm. long, and by Odhner (1923) a male of 50 mm.

Hansen (1895, p. 85), by comparison with the type specimens of both authors, has identified the postlarval stage of this species with *Squilla monodactyla* A. Milne-Edwards (1878) and *Pseudosquilla monodactyla* Miers (1880). It differs from the *monodactyla* stage of *P. ciliata* by its larger size, 28–34 mm. (Kemp, 1913, p. 108); and by the possession of ten to eleven lateral spines on the uropod.

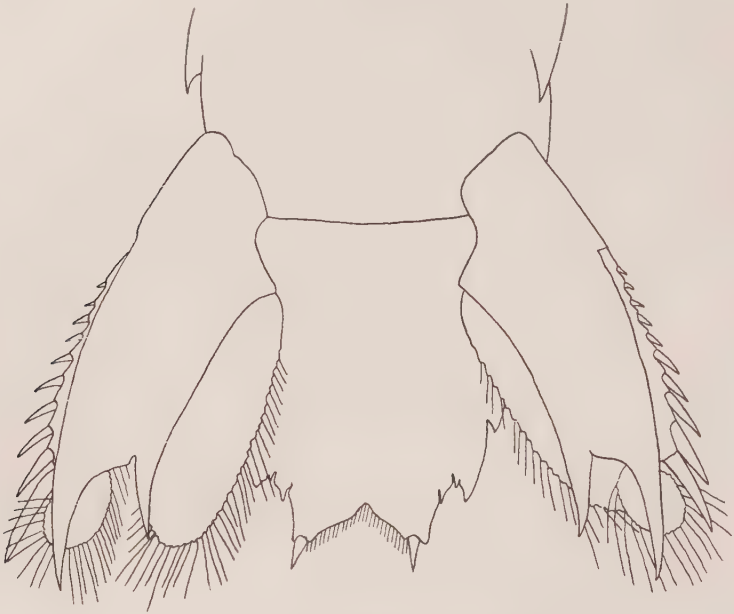


FIG. 8.—Telson and uropods of *P. oculata* in the postlarval stage, ventral aspect.

The collection from the Hawaiian Islands contains nineteen specimens, 24–30.7 mm. in length that appear to be in the *monodactyla* stage of *P. oculata*. They were taken from the surface at six stations during the hours from 7.30 to 8 P.M. or in the early morning (4.15 A.M.).

In addition to the greater length, these specimens differ from the corresponding stage of *P. ciliata* in the form of the rostrum, which is acute at the apex, and about eight tenths as long as wide. With one exception, the outer margin of the uropod is armed with ten or eleven movable spines. The exceptional individual has eight on one side and

ten on the other. The paddle of the exopod is noticeably smaller than in *P. ciliata*; in an average of eleven specimens it is thirty-five hundredths the length of the proximal segment, and the outerspine of the basal process is stronger and its inner border is more sinuous (Fig. 8). The posterior border of the telson shows the median indentation mentioned by Jurich (1904) as characteristic of the *Pseuderichthys* stage and bears thirty-three to thirty-five minute spinules of nearly uniform size. The dorsal surface of the telson is marked by a well defined median crest that extends nearly the full length of the telson and ends in a sharp spine *very close* to the posterior margin (within 0.06 mm.).

On each side of the median crest there is a trace of the intermediate carina, and on one specimen between this and the crest a longitudinal line of pits could be detected.

The eyes are pyriform in lateral view and slightly flattened on the inner side, the maximum vertical diameter being about three-fourths the length.

The raptorial limb is like that of *P. ciliata* (Fig. 6) with a strong terminal spine on the propodus, and beneath the integument of the dactylus are the rudiments of two lateral teeth, faintly indicated in the smaller specimens and well marked in the larger ones. The posterolateral angles of the first to third abdominal somites are rounded, of the fourth and fifth spinous; and on the sixth somite are pairs of submedian and lateral spines, but no intermediate.

List of Stations and Specimens — 1902

Station 3,812 south coast of Oahu	March 27, 7.30 P.M.	3 specimens
Station 3,829 south coast of Molokai	April 1, 8 P.M.	1 specimen
Station 3,837 south coast of Molokai	April 3, 8 P.M.	1 specimen
Station 3,921 off Honolulu, Oahu	May 6, 8.45 P.M.	11 specimens
Station 3,932 off Laysan Island	May 16, 4.13 A.M.	1 specimen
Station 4,086 off Maui	July 21, 7.46 P.M.	2 specimens

These observations, with those of Edmondson (1925), indicate a wide distribution of the species in the Hawaiian Islands, and that while in the *monodactyla* stage it tends to swim at the surface at night. Of the one hundred and sixty-five specimens in this stage, mentioned without description by Edmondson, all but one were taken at two stations of the "Tanager" expedition, one hundred near Pearl and Hermes Reef and sixty-four off Johnston Island (see map, Bishop Mus. Bull. 10, p. 20), and like our specimens were collected from the surface at night.

Table of Measurements

Specimen no.	58b	58c	58d	59	60a	60b	61a	61b	61c	61d	61e	62	63
Station	3812	3812	3812	3837	4086	4086	3921	3921	3921	3921	3921	3829	3932
	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.
Total length	25.2	24.0	24.0	..	30.7	..	..	..	..	..	..	..	..
Carapace length	4.91	4.91	5.08	4.91	6.68	5.40	4.75	5.25	5.08	5.75	5.17	4.92	5.25
Rostrum length	1.42	..	..	..	..	..	..	..	..	..	..	..	..
" breadth	1.67	..	..	..	..	..	..	..	..	..	..	..	..
Telson median length	2.67	..	..	..	4.17	..	..	..	..	..	..	..	..
Telson to base mobile spine	3.08	..	..	..	..	..	..	..	..	..	..	..	..
Telson breadth	3.24	..	..	..	4.17	..	..	..	..	..	..	..	..
Eye vertical diameter	1.50	1.50	1.50	1.50	1.75	..	1.50	1.42	1.58	1.50	1.67	..	1.58
Eye longitudinal diameter	2.00	2.08	2.08	2.00	2.16	..	2.08	2.00	2.00	2.16	2.00	..	2.00
Uropod prox. seg. exopod.	2.25	2.41	2.33	2.50	3.25	2.40	2.08	2.25	2.41	2.25	2.50	2.41	2.50
Uropod distal seg. exopod.	0.83	0.83	0.92	0.75	1.00	0.96	0.83	0.83	0.75	0.92	0.83	0.75	0.83
Dactylus with subdermal teeth	+	+	+	-	+	+	+	?	+	+	+	?	?
Number movable spines on uropod	10	10	10	10	11	10	8-10	10	10-11	11	10	10	10-11
Telson with low intermediate carinae	-	+	+	?	+	?	+	+	-	+	+	+	-

NOTE: The last decimal figure is approximate. The sex in all specimens is indeterminate.

LYSIOSQUILLA Dana

Coronis Latreille, Encycl. Meth. Hist. Nat., 1825, **10**, p. 474 (*nom. praeocc.*, Hubner, 1816).

Squilla (*Squilles fine-tailles*, 1st sect.) H. Milne-Edwards, Hist. Nat. Crust., 1837, **2**, pp. 518-519, pl. 26, fig. 11.

Lysiosquilla Dana, U. S. Expl. Exped., 1852, **13**, Crust., p. 615.

Lysiosquilla Bigelow, Proc. U. S. Nat. Mus., 1894, **17**, p. 502.

Lysiosquilla Kemp, Mem. Indian Mus., 1913, **4**, p. 109.

Lysiosquilla Hansen, Siboga-Exped. Monogr., 1926, **35**, p. 18.

Diagnosis.—Stomatopoda having the body flattened, loosely articulated, and wide — without longitudinal carinae; mandibular palp composed of three segments; merus of raptorial limb articulating terminally with ischium, ventral surface of merus longitudinally hollowed throughout its length, upper margin of propodus finely pectinate, dactylus not inflated at its base and armed with at least five marginal teeth; manus of third thoracic leg large, its outer surface three to four times larger than that of the fourth leg; telson broader than long, with few intermediate denticles or none; inner spine of basal process of the uropods usually longer than the outer one, rarely suppressed.

Type Species.—*L. maculata* (Fabr.).

Species Represented in the Collection.—*L. maculata* (Fabr.).

LYSIOSQUILLA MACULATA (Fabricius)

Squilla arenaria terrestris Rumphius, Amboinische Rariteitkamer, 1705, p. 4, pl. 3, fig. E.

Squilla maculata Fabricius, Ent. Syst., 1793, 2, p. 511.

Cancer (mantis) arenarius Herbst, Nat. Krabben in Krebse, 1796, 2, p. 96, pl. 33, fig. 2.

Lysiosquilla maculata Dana U. S. Expl. Exped., 1852, 13, Crust., p. 616.

Lysiosquilla maculata Kemp, Mem. Indian Mus., 1913, 4, pp. 111–116, pl. 8, figs. 86–91 (with references complete to 1910).

Lysiosquilla maculata Kemp, Philip. Jour. Sci., (D), 1915, 10, p. 174.

Lysiosquilla maculata Alexander, Jour. and Proc. Roy. Soc. W. Australia, 1916, 1, pp. 8, 9, 10.

Lysiosquilla maculata Sunier, Contr. Faune des Indes Néerl., 1918, 4, p. 72, fig. 4.

Lysiosquilla maculata Edmondson, Occ. Papers, P. B. Bishop Mus., 1921, 7, pp. 292–295.

Lysiosquilla maculata var. *sulcirostris* Parasi, Atti Soc. Ital. Sci. Nat., 1922, 61, p. 105.

Lysiosquilla maculata Odhner, Göteborgs Vet. Handl. (4), 1923, 27, (4), p. 7.

Lysiosquilla maculata var. *sulcirostris* Monod, Bul. Soc. Sci. Nat. Moroc, 1925, 5, pp. 88–89, pl. 21, fig. B–E.

Lysiosquilla maculata Hansen, Siboga-Exped. Monogr., 1926, 35, (Livr. 104), pp. 18 and 39–40.

Lysiosquilla maculata Komai, Mem. Col. Sci., Kyoto Imp. Univ. (B), 1927, 3, p. 330.

Diagnosis.—A *Lysiosquilla* without dorsal spines on the telson, the whole dorsal surface of the animal smooth and polished; carapace strongly arched, almost as broad anteriorly as posteriorly, gastric grooves sharp, and cervical groove obsolete; rostrum nearly as broad

or broader than long, cordiform, smooth except for a longitudinal carina in the anterior third; eyes large; three soft papillae on the antennal protopodite; raptorial dactylus in males and young females with nine to eleven long teeth, including the apical one which is not dilated, on the propodus near its proximal end four movable spines; in old females the lateral teeth of the dactylus reduced and the distal pair of movable spines on the propodus reduced or wanting; mandibular palp composed of three segments; shorter ramus of last three thoracic limbs linear; thoracic somites without longitudinal wrinkles, the third and fourth somites exposed; lateral margins of the first to fifth abdominal somites concave, their postero-lateral angles rounded; sixth abdominal somite with swollen lateral lobes, a median smooth area, and on either side sometimes a number of obscure and irregular elevations; at each antero-lateral angle a single strong tooth projecting backward over the ventral surface of the uropod; telson nearly twice as broad as long, with a feeble triangular elevation in both dorsal and ventral surfaces, posterior margin of telson with two to four blunt or acute processes on each side of an indistinct median notch; the basal process of the uropods ending in two long spines, triangular in section and bearing three longitudinal grooves and three carinae, the inner spine nearly twice the length of the outer one; the proximal segment of the uropod with a terminal fixed spine on the ventral side and eight or nine movable spines on its outer margin.

General Description.—The diagnosis given above is a modified abstract of the very full description by Kemp (1913). Our collection contains nine specimens: one male and two females from Samoa; three males and three females from Honolulu. Of these, the largest is a female from Apia, measuring 285 mm. in length.

One large male (258 mm.) has nine teeth on the right raptorial claw and ten on the left, including the apical one. Another male has eleven teeth on both claws, and the other two have ten on the right claw and the left one missing. The smaller females have dactyli like the males with ten long teeth, but the two large ones from Samoa (240 and 285 mm.) have in one nine and the other eight short stout teeth on the dactylus.

The sexual modification of the raptorial limbs in the two large females mentioned above is not so marked as in Kemp's specimen (1913, pl. 8, fig. 90). The teeth on the dactylus are longer, probably like his specimens from the Philippines (1915, p. 174), and the propodus bears four movable spines. These differ, however, from those in the males and smaller females, which are long and nearly evenly

spaced. In the large females they are arranged in two pairs — a proximal pair of two long spines placed close together, and a distal pair of very short spines. Each pair of spines is concealed in a dense tuft of long hairs (Kemp, fig. 90) that arise from the medial edge of the marginal groove, where in other specimens there are only a few scattered hairs.

Perhaps like other collections (Parisi, 1922; Monod, 1925), our specimens are in the form of the rostrum, more or less intermediate between the extreme types figured by Kemp (1913, pl. 8, figs. 86 and 92). Our nine specimens show considerable variation with a tendency

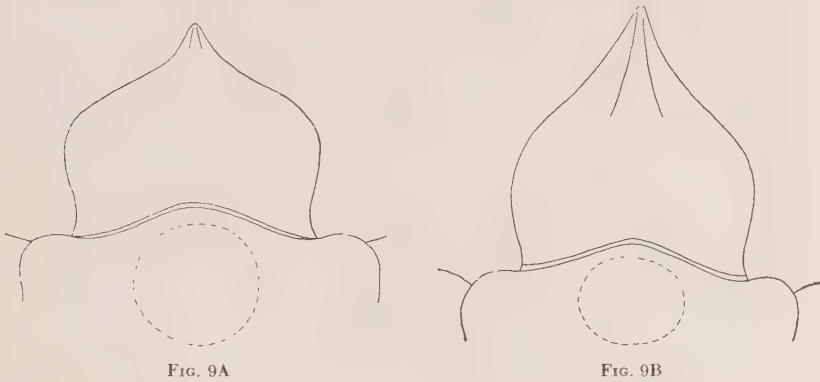


FIG. 9.—Rostrum and anterior margin of the carapace of *L. maculata*. A. Female 285 mm., B. Male, 258 mm. x 3. The eye-spot on the carapace is indicated by the circle of dashes.

toward two types correlated with sex and age. The extremes are shown by the two largest specimens, a female 285 mm. (Fig. 9A), and a male 258 mm. (Fig. 9B). In the female the rostrum is distinctly broader than long, but the apex is more acute than in Kemp's typical form, and there is a very small apical carina not bordered by grooves. The rostrum of the male is about as long as it is broad, with the apex strongly produced, subacute and slightly depressed, and bearing a well marked carina bordered by grooves that diverge posteriorly and extend from the apex nearly to the middle of the rostrum. One of the smaller females (No. 47, 175 mm.) has a rostrum like the males, but all the other females resemble the large one and may be classed with Kemp's typical form, while all the males are more or less alike and might be assigned to Kemp's var. *sulcirostris*, with respect to the rostrum, although they differ from the type of the variety in the number

of teeth on the raptorial dactylus. As suggested by Monod (1925), it is probable that these two characters vary independently.

Another feature in which there is a sexual difference increasing with size has been noticed by Kemp (1913, p. 114). This is in the size of the eyes, which are relatively much smaller in large females than in males of the same size. This is well illustrated by the two large females from Samoa, with a marked increase in Kemp's corneal index (the number of times that the breadth of the cornea is contained in the median length of the carapace), as shown in the table below.

In all of our specimens the sixth abdominal somite appears to be normal, and the outer marginal teeth of the telson are strongly produced and acute.

The uropods of this species have a peculiarly distorted appearance, the exopodite being short and swollen with the movable spines, eight in all of our specimens, arranged in a curved row so that the line of attachment of the distal three spines is nearly at a right angle to the proximal line.

Color.—All of our specimens show the alternate dark and pale bands characteristic of preserved specimens of this species, but with some variations. No specimen is as dark as Kemp's Figure 87, and on every specimen there is a pale patch on the sixth abdominal somite which he states to be, as a rule, wholly pigmented. In the dark band close to the anterior margin of the carapace there is a median eye-spot, nearly half as wide as the rostrum (Fig. 9). It consists of an area of lighter pigment surrounded by a circle of dense pigment. I am informed by Professor R. P. Cowles, who spent many years in the Philippines, that in life the dark bands are slate-color, almost black, and the pale bands are a yellowish cream-color.

Larval Stages.—Hansen (1926) agrees with Brooks (1886) in the inference that the large larval form *Lysioerichthus duvaucellii* (Guérin) is the young of this species, although definite experimental evidence is wanting.

Distribution.—The specimens in the present collection are three males and three females from Honolulu, and one male and two females from Apia in the Samoan Islands. This species is one of the most widely distributed of the stomatopods. The first record from Hawaii is by Randall (1839), and from Samoa by Miers (1879). Kemp (1913) gives a list of ten localities represented by specimens in the Indian Museum, and of twenty recorded by other observers. With one exception, these lie within the Indo-Pacific region, from Durban, South Africa, to the Riu Kiu Islands south of Japan, and from Rodriguez in the Indian

Ocean through the Malay area and the Pacific Islands to Fiji, Tahiti, the Marquesas, and Hawaii. Duke of York Island (Miers, 1877) is now called New Lauenburg. The exception is a specimen sent to Stebbing from Antigua, British West Indies. It exhibits some peculiarities that may indicate a distinct variety. The only other record from the Atlantic region is a specimen identified as var. *sulcirostris* that was collected by Monod (1925) off Cape Blanco, Mauritania. Since the publication of Kemp's monograph, a number of additional records in the Indo-Pacific region have been made by Sunier, Edmondson, Kemp, Parisi, Odhner, Hansen, and Komai; and Alexander has extended the known distribution to King Sound, western Australia. In some places the species is abundant and forms the object of a fishery, as at Honolulu.

Size.—This is the largest of the stomatopods. Specimens over 200 mm. long are not uncommon, and Hansen (1926) reports a male from the Banda Sea 315 mm. in length. The dimensions of our specimens are given in the following table.

Table of Measurements

Station	Serial number	Sex	Total length	Carapace length	Cornea		Rostrum		Number of teeth on raptorial dactylus including terminal one	
					Breadth	Index Kemp '13 p. 9 and 114	Length	Breadth		
Honolulu, 1901	47	♀	mm.	mm.	mm.	mm.	mm.	mm.	R.	L.
" Market, 1902	48	♂	160	30.0	7.4	4.1	6.0	6.3	10	10
" "			199	37.5	9.2	4.0	8.5	8.5	10	..
March 26, 1902	49	♂	212	39.5	9.0	4.4	8.5	8.0	10	..
Honolulu Market, June 25, 1902	50a	♂	181	36.0	9.5	3.8	8.2	7.5	11	11
Honolulu Market, June 25, 1902	50b	♀	191	36.0	7.5	4.8	6.5	7.2	..	..
Honolulu Market, July 25, 1902	51	♀	175	28.0	7.5	3.7	6.5	6.0	10	10
Apia, Samoa, 1902	52	♂	258	50.0	11.0	4.5	10.0	10.2	9	10
" "	53a	♀	285	52.4	9.3	5.6	7.3	10.3	9	9
" "	53b	♀	240	48.0	8.6	5.6	7.8	9.5	8	8

SQUILLA J. C. Fabricius

or CHLORIDELLA Miers

Not *Squilla* L. T. Gronov 1760 and 1764.

Not *Squilla* O. F. Müller 1776.

La squille Rondelet, Histoire entier des poissons, part 1, 1558, pp. 396-398, fig., p. 397.

Squilla Seba, Locupletissimi rerum naturalium Thesauri, 1758, **3**, pp. 50-51, pl. 20, fig. 2, 3, 6 (*partim*).

Squilla DeGeer, Mémoires pour servir à l' Histoire des Insectes, 1778, **7**, p. 533, pl. 31, fig. 1 (*partim*).

Squilla J. C. Fabricius, Mantissa Insectorum, 1787, **1**, p. 333 (*partim*).

Squilla Lamarck, Système des animaux sans vertèbres, 1801, p. 160 (*partim*).

Squilla Latreille, Histoire naturelle des Crustacés et des Insectes, 1802, **3**, p. 36; 1803, **6**, pp. 271-281 (*partim*).

Squilla Latreille, Encycl. Méthod., 1825, **10**, p. 467 (*partim*).

Squilla Miers, Ann. Mag. Nat. Hist., (5), 1880, **5**, p. 16.

Chloridella Miers, *ibid.*, 1880, p. 12.

Squilla Brooks, Voy. H. M. S. "Challenger," 1886, **16**, Stomatopoda, p. 23.

Squilla Bigelow, Proc. U. S. Nat. Mus., 1894, **17**, p. 509.

Squilla Hansen, Isop. Cumac. u. Stomatopoda Plankton Exped., 1895, p. 69.

Chloridella Rathbun, Proc. U. S. Nat. Mus., 1902, **26**, p. 54.

Squilla Stebbing, Ann. S. Africa Mus., 1910, **6**, p. 405.

Chloridella Rathbun, Proc. U. S. Nat. Mus., 1910, **38**, pp. 565, 608.

Squilla Kemp, Mem. Indian Mus., 1913, **4**, pp. 16-19.

Squilla Kemp, Philippine Jour. Sci., (D), 1915, **10**, p. 169.

Squilla Calman, Brit. Antarct. ("Terra Nova") Exp., 1910, Nat. Hist. Rep. Zoöl., 1917, **3** (5), pp. 137-162.

Squilla Sunier, Contr. Faune Indes Néerl., 1918, **1**, (4), pp. 65-72.

Squilla Kemp and Chopra, Rec. Ind. Mus., 1921, **22**, pp. 297-311.

Squilla Edmondson, B. P. Bishop Mus. Occ. Papers, 1921, **7**, (13), pp. 287-288.

Squilla Parisi, Atti Soc. Ital. Nat. (Milano), 1922, **61**, pp. 91-103.

Squilla Odhner, Göteborgs Vet. Handl., (4), 1923, **27**, (4) pp. 1-6.

Squilla Monod, Bul. Soc. Sci. Nat. Maroc., 1925, **5**, pp. 86-88.

Squilla Hansen, Siboga-Exped. Monogr., 1926, **35**, p. 3.

Squilla Komai, Mem. Coll. Sci., Kyoto Imp. Univ. (B) 1927, **3**, (3), pp. 308-323.

Diagnosis.—*Stomatopoda* having the hind body depressed, with longitudinal carinae; carapace narrower in front than behind, with gastric and cervical grooves, and more or less distinct longitudinal carinae; cornea of eyes usually bilobed; mandibular palp three-segmented or absent; merus of raptorial claw articulating terminally with ischium; upper margin of propodus finely pectinate or with a series of

long stiff spines; dactylus not inflated, with teeth on inner margin; shorter ramus of last three thoracic appendages linear, with or without an imperfect suture between basal and distal parts; telson with median carina, the dorsal surface on either side smooth, pitted, tuberculate or carinate, and the posterior margin with three pairs of large teeth, and on each side of median line one or more submedian denticles, more than four intermediate, and one lateral; ventral process of uropods terminating in two sharp spines, of which the inner one is the longer.

Remarks on Nomenclature.—The genus *Squilla* J. C. Fabricius, or *Chloridella* Miers, is not only as stated by Kemp (1913), from whom the above diagnosis is quoted in part, the oldest established, but also is the most numerous in species, and the most typical genus of the order. Kemp thinks it also the most primitive. As established by Fabricius in 1787, it contained exclusively all the Stomatopoda then known, including the common European form that had been described in 1778 by DeGeer under the name *Squilla mantis*. The genus is described, and five species, with references to previous descriptions and figures.

The genus *Squilla* of Fabricius was accepted by Lamarck in 1801, and by Latreille in 1802, and the name then given to the typical genus of Stomatopoda remained unquestioned for more than a century. It was in 1899 that Miss Rathbun called attention to O. F. Müller. Later Sherborn (1902, p. 926) found that the first application of the name "*Squilla*" to a genus of animals made after January 1, 1758¹ was by L. T. Gronov, 1760. One species was defined "*Squilla acaudata pedibus quatuordecim*" with a very good figure of an amphipod afterward described by Slabber (1769) as *Phtisica marina* and by O. F. Müller (1776) as *Squilla ventricosa* (Stebbing 1888, p. 19; 1910, p. 405).

From early times the name "*la squille*" or "*Squilla*" seems to have been applied by fishermen to various shrimp-like animals. This usage is reflected by Rondelet (1558), who includes under this name several shrimps and prawns including (p. 396–398, fig.) the mantis shrimp, *Squilla mantis*. Later, when they became known to naturalists, various species of amphipods and isopods were included in this comprehensive genus *Squilla*—for example Seba (1758) and DeGeer (1778).

In revising the genus *Squilla*, Fabricius (1793) refers to Seba (1758), and the latter seems to have priority over Gronov (1760), whose standing as a binomialist is perhaps equally open to question (see International Rules 1926, Opinion 89). The reference is to plate 20, figs. 2, 3, and 6. Figures 2 and 3 are supposed to represent *Squilla mantis*

¹ Rules, Art. 26, and Opinion No. 3.

DeGeer, but figure 2 is without doubt *S. raphidea* Fabricius (1798), and figure 3, with five teeth on the dactylus and the lateral process of the fifth thoracic somite strong, acute, and very slightly curved forward, is more like *S. prasinolineata* or *S. defresnii* Miers. Figure 6 is *Odontodactylus scyllarus* (L.).

The definition of Gronov (1760) has generally been ignored, except by Scopoli (1777) who includes it in a list of genera, without mentioning any species. The revision of Fabricius was welcomed with enthusiasm by Latreille (1803, p. 271), who, after discussing the previous usage, says: "Fabricius has finally removed this confusion, and the genus of the squilles is now circumscribed in convenient limits, being perfectly natural."

Fabricius in 1793 included in the genus five species. The first, *S. maculata*, has been placed in the genus *Lysiosquilla* Dana (1852); the second, *S. mantis* (L.) DeGeer (1778)¹, remains the type of the genus *Squilla*; the third, *S. scyllarus* (L.), and the fifth, *S. chiragra*, were placed by Latreille (1825) in his new genus *Gonodactylus*; and the fourth of these species, *S. ciliata*, was added (under another name) by Dana (1852) to his genus *Pseudosquilla*. In 1841, Eydoux and Souleyet proposed the generic name *Chlorida* for some species with very small eyes. Finding this name preoccupied, Miers (1880) changed it to *Chloridella*. But Brooks found (1886) that these forms are linked to the typical species of *Squilla* by such forms as *S. lata* and *S. fasciata*. Miss Rathbun (1902) regards the name *Squilla* as a homonym (Rules, Art. 23) and the name *Chloridella* as the only available one for the genus, but this has been disputed by Stebbing (1910), and has not generally been admitted.

In his monograph of the Stomatopoda, Kemp (1913, p. 3) gives a list of fifty-four known species and varieties of *Squilla*. In spite of the addition of many new species, the limiting characteristics of this genus have remained practically unchanged since the publication of the "Challenger" Report (Brooks, 1886), and in nearly all important monographs and other papers from 1793 to the present time, the name *Squilla* has represented a genus of Stomatopoda that contains the common European form, the type species. The various unrelated eighteenth century species associated with this name have long since been discarded into the synonymy, or have been placed in other genera.

It is evident, therefore, that to substitute for this familiar name another, in "strict application of the rules, will clearly result in greater

¹ See Sherborn, 1902, p. 583.

confusion than uniformity" (Rules, 1926, p. 88). For this reason, the name *Squilla* is retained here, and a petition is being presented to the International Commission on Zoölogical Nomenclature to suspend the rules as applied in this case.

Calman, 1917, first drew attention to the importance of the number of epipodites on the thoracic limbs as a specific criterion in the genus *Squilla*. Kemp and Chopra (1921)¹ have followed up this suggestion by examining all the forms represented in the Indian Museum, and they give lists of species,—in five species epipodites are found on the first five thoracic limbs; in thirty, on the first four; in one, on the first three; and in three, on the first two only. They also indicate those species lacking a mandibular palp. They conclude that, while these two characters have definite specific value, they cannot be used as a guide to the affinities of the different forms.

Type Species.—*Squilla mantis* (L.) DeGeer, 1778; (Sherborn, 1902, p. 583); Latreille, 1802.

Species Represented in the Collection.—*S. mauiana* n. sp.; *S. polita* Bigelow; *S. oratoria* De Haan.

SQUILLA MAUIANA spec. nov.

Provisional Diagnosis.—A *Squilla* with small eyes, the cornea bilobed and nearly transverse, its axis about two-thirds the length of the eye-stalk; ophthalmic somite exposed, with dorsal processes meeting in the median line and closely applied to the base of the eye-stalks, distal edges straight and meeting at nearly a right angle; antennal scale when extended reaching to anterior margin of cornea; mandibular palp absent; raptorial dactylus with five long marginal teeth, including the terminal one, and a prominent external tuberosity near the articulation; propodus strongly pectinate and bearing three long movable spines; carpus with a dorsal crest ending in a small spine, the ventral external margin of the merus rounded; epipodites present on the first and second thoracic limbs; hand of fourth thoracic limb longer than broad and larger than the fifth; rostrum smooth, about as broad as long, with sides converging slightly toward the semicircular apex; carapace smooth, with well marked gastric and cervical grooves; anterior margin angular, from gastric groove outward transverse; anterolateral angles square, postero-lateral lobes rounded and bordered

¹ Cf. also Hansen (1926, p. 1).

by a marginal carina, lateral and posterior margins concave, a small but distinct median tubercle at posterior margin; exposed thoracic somites smooth, lateral margin of the fifth slightly produced as a short subvertical lateral keel quite separate from the prominent, acute, procurved ventrolateral spine; lateral margins of sixth and seventh thoracic somites truncate and slightly thickened at edge; the appendages of the walking legs are broad and flat with parallel sides; first to fifth abdominal somites without submedian carinae, intermediate carinae slightly developed on third to fifth somites, lateral and marginal carinae present on all five somites; on the fifth the postero-lateral angles are spinous; sixth abdominal somite with very low submedian, intermediate, and lateral carinae ending in spines, and in addition a transverse row of small spines at the posterior margin; telson with six marginal teeth, the submedian pair having mobile tips, denticles 5, 8-9, 1, acute; dorsal surface of telson convex with a large elevated central area and a lower marginal area separated by a transverse declivity parallel to the margin and becoming less abrupt laterally; in the center of the elevated area a shield-shaped figure formed by a pair of grooves that converge under the spine at the posterior end of the low median crest; on the edge of the shield near the posterior ends of the grooves, a row of a few small spines; at the brink of the declivity a row of five or six stout, acute spines on each side of the telson at the posterior ends of very short longitudinal carinae; the narrow marginal area of the telson crossed by the dorsal carinae of the submedian and intermediate marginal teeth, marginal carinae present; ventral surface of telson slightly roughened on each side of a single postanal keel; the basal segment of the uropods with a dorsal longitudinal carina bearing three to four spines, the distal one being at the articulation with the exopodite, on the dorsal surface of which the ridge extends and there bears three small spines; basal process of the uropods armed on the inner margin with about sixteen elongated, sharp spines, and terminating in prongs, of which the inner one is much the longer and nearly reaches the apex of the paddle; both prongs broad toward the base with a prominent adaxial lobe on each one, the terminal slender portion of the inner prong being longer than the same part of the other; proximal segment of the exopodite with seven or eight movable spines, the distal one being more than three-fourths the length of the paddle, the endopodite narrowly spatulate and its entire border beset with setae.

Special Description.—One naturally hesitates before describing as new a species represented by a single, immature, and mutilated speci-

men. The specimen in question is a male (our No. H. 57) 21.27 mm. in length, from Hawaii. It has lost one entire raptorial limb and the distal part of the dactylus of the other, also some other minor parts. The intromittent organs are fairly well developed, their tips meeting at the median line.

In spite of its somewhat immature condition this specimen exhibits a peculiar combination of characters that appear clearly to distinguish it from any species of which I have been able to find a published description. It resembles *Squilla chlorida* Brooks, also known from a unique small male (39.9 mm.), but its nearest relative is *S. incerta* Hansen (1926). From this species it differs in a number of particulars that may be summarized by saying that it has more spines and fewer carinae. These might be regarded as juvenal characteristics. But Hansen's specimen, also a male, is only 24 mm. in length, less than 3 mm. larger than ours, and there cannot be much difference in age. Moreover, there are some differences that can hardly be attributed to that cause. That the two forms are specifically distinct is also made probable by the great distance between the localities where they were found. The two forms are alike in the shape of the eyes, the structure of the antennae, absence of mandibular palps, structure of the raptorial and other thoracic limbs, shape of rostrum, margins of thoracic somites, general smoothness of dorsal surface from carapace to abdomen, arrangement of sculpturings on the telson, and form of the uropods (Fig. 10).

In detail there are many differences. Although mutilated, from the structure of the propodus it is evident that the dactylus of the left raptorial claw had five teeth including the terminal one, not six — the right claw is lost. The epipodites are present on only the first and second thoracic limbs, but they may have dropped off from the others. Hansen's specimen has them on the first four pairs.¹ In our specimen there are no traces of a carina on the rostrum, of lateral carinae on the carapace, or of intermediate carinae on the exposed thoracic somites. All carinae on the abdominal somites are poorly developed and difficult to observe. The postero-lateral angles of the fifth abdominal somites are provided with a minute spine below a rounded lobe. On the sixth abdominal somite the usual six spines are prominent in our specimen, but the corresponding carinae are very poorly developed or absent, and this segment has a peculiar feature at the posterior margin where it joins the articular membrane. This is a row of minute sharp spines. There are three or four between the submedian and intermediate spines,

¹ Hansen's notation differs from Kemp, whom we follow.

and one or two between the intermediate and lateral. The number of marginal denticles on the telson is greater than in *S. incerta*, and on the dorsal surface the "pair of carinae converging backward" of that species is represented in our species by a series of small spines; there is no trace of the "parallel keel," and the four "short longitudinal

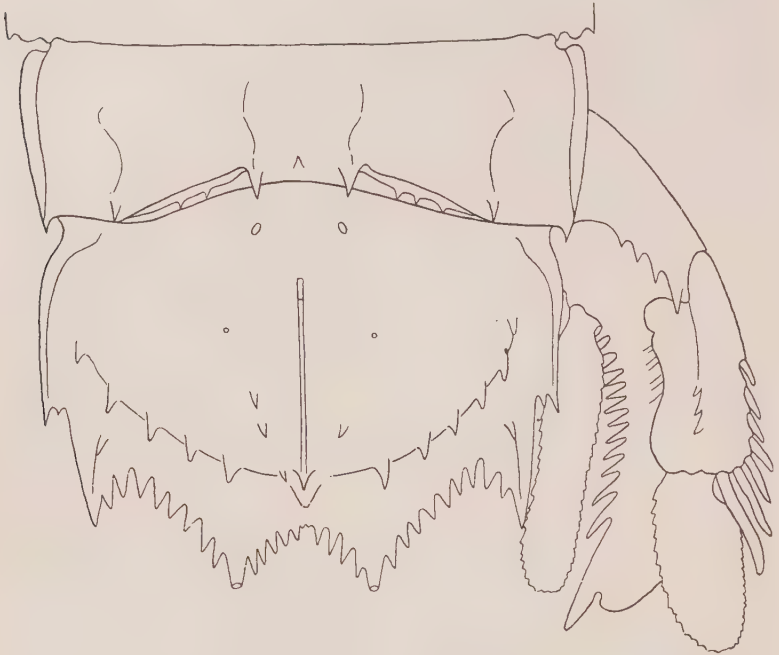


FIG. 10.—*Squilla mauiana* type. Sixth abdominal somite, telson, and uropod; dorsal aspect, x 8. Outline of central shield indicated by position of small spines near the median crest; dorsal carinae of submedian marginal teeth not shown.

keels", terminating a little from the hind margin, are represented by a transverse series of stout, sharp spines — six to the right and five to the left of the median line. These spines point directly backward and at their bases are continuous with very short carinae. Hansen does not mention spines in this position and his figure clearly indicates their absence. In the marginal area the intermediate, as well as the submedian, teeth bear carinae on the dorsal surface. On the uropods the most peculiar feature is the series of spines on the dorsal carina of the basal segment and of the first segment of the exopodite. This seg-

ment on its outer margin carries seven or eight movable spines, instead of five or six, the number of sharp spines on the inner margin of the basal process is about sixteen, instead of eleven or twelve, and the apical part of its inner prong is longer than the outer one.

This species resembles also *S. fallax* Bouvier (1914), from which it differs in the number of teeth on the dactylus, sculpturing of the telson, and the form of the uropods. It is like *S. fasciata* De Haan and *S. miles* Hess, but differs from both, as it does also from *S. chlorida* Brooks, in the sculpturing of the telson and in many other particulars. It differs in the shape of the eyes from *S. rotundicauda* Miers and from *S. microphthalmia* H. Milne Edwards.

Locality.—The single specimen, a male, was taken by the "Albatross" with the beam trawl April 14, 1902, at station 3,876 in Auau Channel between Maui and Lanai Islands (Hawaiian group) in 28–43 fathoms with sand and gravel bottom. Hansen's specimen of *S. incerta* was found at Siboga Exp. sta. 154, N. lat. $0^{\circ} 7'$, E. long. $130^{\circ} 25'$, off Waigeu Island, northwest of New Guinea, depth 59–83 M., bottom muddy sand.

Table of Measurements

made with micrometer eyepiece

Specimen No. H 57 ♂ Station 3,876, April 14, 1902

Total length, median line	21.27 mm.
Eye, total length	1.44
Cornea breadth	1.04
Eye-stalk, breadth	0.88
Corneal index (Kemp's)	3.85
Antennal scale	1.52
Rostrum, length	0.76
Rostrum, breadth at base	0.72
Carapace, length median line	4.00
Carapace, breadth at antero-lateral angles	2.33
Carapace, maximum breadth	3.34
Length on median line, exposed thoracic somites	4.01
Length on median line, abdominal somites 1–6	10.00
Length on median line, telson	2.50
Breadth, fifth abdominal somite	4.25
Breadth, telson	3.75
First antenna, peduncle, length about	3.6

Propodus, fourth thoracic limb, 0.75 mm. broad, 1.08 mm. long	
Propodus, fifth thoracic limb, 0.50 mm. broad, 0.90 mm. long	
Uropods: basal segment, outer edge.....	1.24 mm.
basal process inner side, articulation to tip of	
inner prong.....	2.16
length of paddle.....	1.33
length of endopodite.....	1.75

SQUILLA POLITA Bigelow

Squilla polita Bigelow, Johns Hopkins Univ. Circ. **10**, no. 88, 1891, p. 93-94.

Squilla polita Bigelow, Proc. U. S. Nat. Mus., 1894, **17**, pp. 513-515, fig. 8.

Squilla polita Kemp, Mem. Indian Mus., 1913, **4**, p. 201.

Squilla polita Kemp and Chopra, Rec. Indian Mus., 1921, **22**, p. 298.

Diagnosis.—Eyes of medium size, triangular, with cornea set obliquely to the stalk; dactylus of raptorial claw with four teeth, including the terminal one; mandibular palp absent; epipodites present on the first four thoracic limbs; rostrum ovate without carinae; carapace without carinae, except on postero-lateral lobes, which are rounded; cervical suture obsolete on the median line, antero-lateral angles acute; lateral spine of the fifth thoracic somite broad, obtuse, and curved forward, the ventro-lateral spine elongated, curved forward and acute; lateral processes of the next two somites rounded; hind body without submedian carinae, except the sixth abdominal somite; telson with a dorsal crest and a ventral keel, with a few curved lines of pits on each side; six large marginal spines, the submedian pair having movable tips, and on each side of the median sinus two to four submedian denticles, nine to twelve intermediate, and one lateral one; inner spine of the basal process of the uropod nearly twice the length of the outer one, its basal half broad with a conspicuous rounded lobe on its outer side where it joins the slender distal half, proximal segment of the exopodite with five or six movable spines.

General Description.—It is unnecessary to repeat the extended description of the type forms (Bigelow, 1894). The one specimen in the collection, a male taken by the "Albatross" in Monterey Bay, differs from the type only in minor details. It has four submedian denticles on the telson and six movable spines on the uropod. It confirms the statement of Kemp and Chopra (1921) that the mandibular palp is absent and that the fifth thoracic limbs lack the epipodite. The corneal index (see p. 172) is 4.4.

The following abdominal carinae end in spines:

<i>Carinae</i>	<i>Abdominal somites</i>
Submedian	6
Intermediate	(3), 4, 5, 6
Lateral	3, 4, 5, 6
Marginal	4, 5

The present specimen is without distinctive pigmentation and there is no record of the color in life.

Distribution.—Our specimen, a male 48 mm. long, was taken by the "Albatross" with the tangle at depth of 46 to 54 fathoms in Monterey Bay, California, station No. 4,548, three miles off Point Pinos lighthouse. This is the most northern record for the species. Previous records are from Santa Rosa Island, California, and Point Abrejos, Lower California.

Size.—The largest specimen on record is 63 mm. in length (Bigelow, 1894).

Table of Measurements

Specimen No. E. P. 54 ♂, station 4,548, June 7, 1904.

Total length, median line, 48 mm.

Rostrum: length, 1.6 mm.; width, 1.8 mm.

Carapace: length, 11.0 mm.; width at antero-lateral angles, 5.7 mm.; maximum, 8.0.

Length exposed thoracic somites, median line, 7.5 mm.

Length six abdominal somites, median line, 22.0 mm.

Breadth fifth abdominal somite, 10.5 mm.

Telson: length median line, 5.2 mm.; maximum width, lateral spines, 9.0 mm.

Eye: inner margin, 3.0 mm.; cornea, 2.5 mm.; corneal index, 4.4.

Antennal scale, 4.5 mm.

SQUILLA ORATORIA De Haan

Squilla oratoria De Haan in Siebold's Fauna Japonica, Crust., Atlas, 1844?, pl. 51, fig. 2.

Squilla affinis Berthold, Abh. Ges. Wiss. Göttingen, 1845, **3**, p. 26, pl. 3, figs. 1, 2.

Squilla oratoria De Haan in Siebold's Fauna Japonica, Crust., 1849, p. 223.

Squilla nepa Miers, Ann. Mag. Nat. Hist., (5), 1880, **5**, p. 25 (*partim*).

Squilla nepa Brooks, Voy. H. M. S. "Challenger," 1886, **16**, Stomatopoda, p. 25.

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Squilla oratoria Parisi, Atti Soc. Ital. Sci. Nat. (Milano), 1922, **61**, p. 98.
Squilla oratoria Hansen, Siboga-Exped. Monogr., 1926, **35**, p. 11.
Squilla oratoria Komai, Mem. College of Sci. Kyoto Imp. Univ., (B), 1927 **3**, (3), pp. 314–318.

Diagnosis.—A *Squilla* with large triangular eyes, the corneal axis being oblique and as long as, or usually longer, than the peduncular one and about 0.05 times the length of the body — the corneal index (Kemp, 1913, p. 9) varies from 3.8 in small to 6.0 in the largest specimens; anterior margin of ophthalmic somite squarely truncate or emarginate, never pointed; mandibular palp present; raptorial dactylus with six teeth, including the terminal one and its outer margin, distinctly sinuate; dorsal carina of the raptorial carpus bearing two to five tubercles in large specimens, and the inferior margin of the merus produced to a sharp and prominent spine; epipodites present on the first four thoracic limbs; rostrum subquadrate, its sides frequently upturned and convergent, and with a median tubercle; dorsal surface of carapace and abdomen strongly punctate, never polished; five carinae on the carapace, the median one being sharp and distinct throughout its course and bifurcated in front for only about one quarter its length anterior to the cervical groove; the breadth of the carapace behind the antero-lateral angles less than half its length, including the rostrum, lateral carinae continued into the antero-lateral spines, posterior lobes rounded; margins of sixth, seventh and eighth thoracic somites bilobed, the sixth without ventral spine, and having the anterior lobe of the lateral margin parallel-sided and much narrower but scarcely shorter than the posterior lobe; submedian carinae present on all somites, from the seventh thoracic to the sixth abdominal; the following abdominal carinae ending in spines:

<i>Carinae</i>	<i>Abdominal somites</i>
Submedian	(4), 5, 6
Intermediate	(1), (2), (3), 4, 5, 6
Lateral	(1), (2), 3, 4, 5, 6
Marginal	1, 2, 3, 4, 5

dorsal crest, ventral keel, and symmetrical lines of pits on surface of telson, six marginal spines, eight basal carinae, denticles — submedian 3-5, intermediate 6-10, lateral 1; inner prong of the basal process of the uropod longer than the other and bearing on its outer edge a small lobe, anterior to which the margin is always strongly concave.

Remarks.—For the sake of uniformity, which I regard as more important than priority, I am following Kemp, Parisi, Hansen, Komai, and others in accepting Stebbing's statement (1908) that the atlas to the Fauna Japonica containing De Haan's figure and name *S. oratoria*, antedates Berthold's paper. Sanborn (1902) does not accept this, but gives 1849 as the date of the name *oratoria* as applied to *Squilla*, whereas the date of *affinis* is 1845. In fact there seems to be no evidence of the date of De Haan's plate. All we have is his own claim of priority (cf. Sanborn, 1902, p. 7). Kemp (1913) states that this species is the most variable in the group to which it belongs. He has set apart as var. *perpensa* the form which occurs on the coast of British India, and which may be distinguished by certain fairly constant characters.

The two specimens in our collection are both of the typical form and are from the Hawaiian Islands. They are like the British Museum specimens from the same region (Kemp, 1913, p. 68) in having only two tubercles on the dorsal margin of the raptorial carpus, in the shape of the rostrum, and in having spines at the ends of the submedian carinae of the fourth abdominal and of the lateral carinae of the first and second abdominal somites. In the larger specimen the intermediate and lateral carinae of all the abdominal somites end in spines, and in this specimen the antero-lateral process of the sixth thoracic somite is shorter than the posterior. In the smaller specimen this feature is typical.

Color.—The color of living examples of this species is probably as variable as in other species of Stomatopoda (e.g. *Gonodactylus*). Fukuda (Komai) (1910) gives a detailed description of the color in life of the Japanese forms. They have brilliant markings of green, red, purple, blue, orange, and black on a grayish ground color, punctate with minute black spots. Edmondson (1921) describes the specimens from Honolulu market as reddish brown with black patches on the uropods, and the dactyli light in color.

Ontogeny.—The breeding season of this species in Japan is from April to July. The female holds the egg cluster in her maxillipeds until the eggs are hatched. Komai (1924) has studied the embryology from the blastula stage to the stage with pigmental eyes, and has studied

also the larval stages (1927). The youngest larvae have a length of 3.5 mm., and the largest is usually about 20 mm., but may reach 57 mm.

Distribution.— This is the commonest stomatopod in Japan (Komai, 1927) where it inhabits the muddy bottoms of bays and inlets. It makes U-shaped tunnels in the mud, one to two inches in diameter, with two entrances one and one-half to two and one-half feet apart.

Our specimens were taken in Hawaii, No. 55 at Honolulu and No. 56 at Hilo. This represents the extreme northeastern point of the range of the species. From there it extends through Japan, Formosa (Komai, 1927) and the Chinese coast to Singapore (Parisi, 1922). The "Siboga" Expedition found a very small specimen (18 mm.) in the southern part of Molo Strait (Hansen, 1926, p. 11) and the Indian Museum has two specimens from Mauritius (Kemp, 1913, p. 68, footnote). On the Chinese coast the range of the typical form overlaps that of var. *perpensa*, which is the only form found on the coast of British India (Kemp, 1913) and in the Philippines (Kemp, 1915).

Use for Food.— This crustacean is one of the objects of fisheries in Tokyo Bay (Komai, 1927), and is offered for sale in the Hawaiian markets (Edmondson, 1921).

Size.— Our specimens are two females, 89 mm. and 176 mm. long. Komai records numerous specimens varying from 27 to 182 mm. in length.

Table of Measurements

Specimen	No. 55 mm.	No. 56 mm.
Total length.....	176.0	89.0
Carapace length.....	35.0	19.0
Carapace breadth anterior angles.....	17.0	10.0
Rostrum length.....	6.0	3.0
Rostrum breadth.....	5.0	3.0
Cornea.....	7.0	5.0
Length thoracic somites.....	30.0	13.0
Length first to sixth abdominal somite.....	75.0	37.5
Length telson median line.....	27.0	14.5

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EXPLANATION OF PLATES

PLATE 1

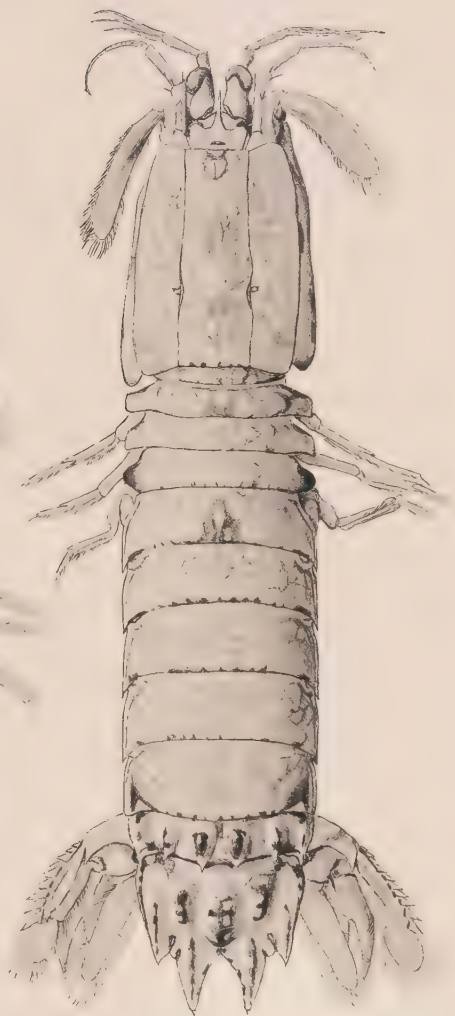
PLATE 1

Fig. 1. *Odontodactylus japonicus* (De Haan) male, 115 mm. (No. 20). About life size.

Fig. 2. *Gonodactylus chiragra* var. *platysoma* (Wood Mason), male, 81.5 mm. (No. 13). $\times 1\frac{2}{3}$.



1

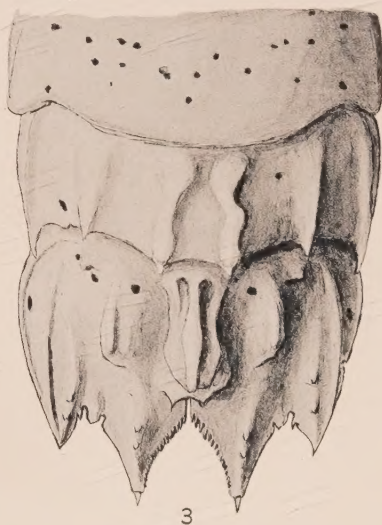


2

PLATE 2

PLATE 2.

- Fig. 1. *Gonodactylus chiragra* (Fabricius), male, 46 mm. (No. 9). $\times 1\frac{2}{3}$.
Fig. 2. *Gonodactylus chiragra* var. *platysoma* female, 70 mm. (No. 14a). $\times 1\frac{2}{3}$,
Fig. 3. *Gonodactylus oerstedii* var. *festae* (Nobili), female, 33 mm. (No. 54).
Sixth abdominal somite and telson, dorsal aspect. $\times 6$.
Fig. 4. Same specimen in lateral view. $\times 3\frac{1}{3}$.



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